TEXTILE RESEARCH

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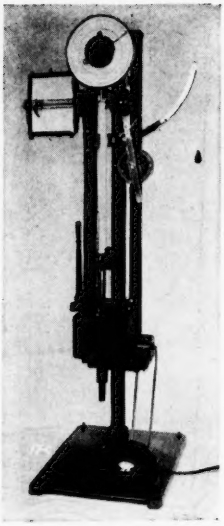

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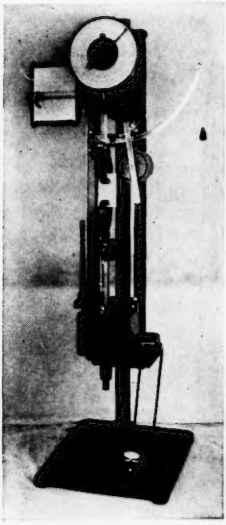

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TESTERS

Tenth Annual Meeting Proceedings

THE TENTH ANNUAL MEETING, and the starting of the tenth year of U. S. Institute for Textile Research, were featured by a condensed but unusually important program, which in addition to the routine meetings of members and directors included an open research conference on wool fibre damage in processing, and a symposium on Textile Foundation and Institute research. All sessions were held at the Hotel Pennsylvania, New York, N. Y., Thursday, Nov. 2, starting at 11 A.M., and concluding at 4.30 P.M.

The program of sessions was as follows:

11 A.M.—Annual Meeting.
12 Noon.—Meeting of Directors.
12.30 P.M.—Luncheon Meeting.
2.00 P.M.—Open Research Conference.

Permanent Research Financing Needed

Perhaps the most notable feature of this series of meetings was the warning to the industry, in the annual address of President Killheffer, that if they do not adequately support this, or possibly some new textile research body, they will have no domestic source of new fundamental research at the end of ten years, since the Textile Foundation, which is the only textile research body that has adequate finances, has adopted a policy that will exhaust its funds by that time. Chairman Franklin W. Hobbs of the Foundation's board of directors confirmed the fact that their present program of annual research expenditure will exhaust the fund in about ten years, but called attention to the fact that the Foundation is authorized to accept gifts of funds, although none have been proffered thus far. President Killheffer further called attention to the fact that the Institute was organized primarily for fundamental research promotion and conduct, and that it was the only textile body that had demonstrated its ability to function on a co-operative basis of financing,

admitting, however, that the Institute had failed thus far to provide an adequate program and financing. He referred to a proposal having this objective in view that he made two years ago, and in conclusion he suggested that the Textile Foundation or the Institute should call a conference, to include the officers of every textile association, with the objective of developing a plan of self-assessment adequate to finance a comprehensive and continuing research program.

The Luncheon Meeting

Following luncheon President Killheffer presented his annual address previously referred to, the remainder of the speaking program being devoted to brief outline reports of Institute and Textile Foundation researches now in progress. Franklin W. Hobbs, president, Arlington Mills and Chairman of the Textile Foundation, introduced the speakers who reported on that body's research: Dr. Robert E. Rose, chairman Advisory Committee on Scientific Research, and a director of the Institute, and Fessenden S. Blanchard, member of the Foundation's Advisory Committee on Economic Research, and chairman of the Institute's Committee on Economic Research.

For the Institute, Chairman W. D. Appel, of the Research Council, reported on the research on Warp Sizing of Spun Rayon and Cotton-Spun Rayon that is starting at North Carolina State College Textile School, Raleigh, N. C., and introduced Dr. A. C. Walker, chairman Administrative Committee for the Institute's Textile Drying Research at the National Bureau of Standards, now in its third and final year.

Wool Damage in Processing Discussed

"That the wool fibre, in its conversion from the natural greasy state to a finished fabric, is subjected to terrific punishment, a great deal of which may be found unnecessary and avoidable, if examined in the light of its known chemical and physical properties," was declared by Rinaldo A. Lukens of the Continental Mills, Inc., Philadelphia, Pa., who opened the discussion on the subject of "Wool Processing in the Light of New Knowledge of the Chemical and Physical Properties of Wool" at the afternoon open conference at which Chairman W. D. Appel of the Research Council presided.

Prior to Mr. Lukens' talk new knowledge of the chemical properties of wool had been presented by Dr. Milton Harris, director of Textile Foundation scientific research at the National Bureau of Standards, and that pertaining to its physical properties by Werner Von Bergen of Forstmann Woolen Co., Passaic, N. J. Dr. Harris devoted the major part of his paper to a discussion of a mechanism for the dyeing of wool with acid dyes and some of the factors which affect levelling, bleeding and wash-fastness; an explanation of the action of bacteria and enzymes on wool fibres; and the description of a method for altering the organic structure of wool in such a way as to produce a new wool product which has many unique properties. Mr. Von Bergen outlined existing knowledge relating to determination of the main properties of wool quality—fineness, length and strength; discussed

the new government top standards, and the progress in sampling and scouring raw wool for shrinkage determination.

Open discussion, following the talks of Messrs. Harris, Von Bergen and Lukens, reflected general interest in the subjects presented, and is presented in outline form on another page. When discussion was completed it was voted practically unanimously, by that part of the audience who were engaged in wool manufacture, that they favored a scientific study of the problem. It was also agreed that a committee be appointed by the Research Council to review the conference papers and discussion and draw up a research program and methods for its conduct that can be used in a canvass for financial support.

Officers and Directors Elected

At the annual meeting of members formal reports were presented, and the following directors were elected for a term to expire in 1942: Arthur Besse, president, National Association of Wool Manufacturers, New York, N. Y.; H. M. Chase, research director, Riverside and Dan River Cotton Mills, Danville, Va.; Daniel E. Douty, president, U. S. Testing Co., Hoboken, N. J.; Ephraim Freedman, director, R. H. Macy & Co.'s Bureau of Standards, New York, N. Y.; Russell T. Fisher, president, National Association of Cotton Manufacturers, Boston, Mass.; H. Grandage, vice-president, Clark Thread Co., New York, N. Y.; Edward R. Schwarz, professor of textile engineering, Mass. Institute of Technology, Cambridge, Mass.; the Chairman of the Research Council, ex officio.

For a term expiring in 1940: W. M. McLaurine, secretary, American Cotton Manufacturers' Association, Charlotte, N. C., succeeding Philip A. Johnson, resigned. The only new members of the Board are Messrs. Fisher and McLaurine.

At the meeting of the Board of Directors all officers and members of the Executive Committee were re-elected.

Minutes of Annual Meeting

PURSUANT to a call issued Oct. 19 the annual meeting of the Institute was held at the Hotel Pennsylvania, New York, N. Y., Thursday, Nov. 2, and was called to order by President Killheffer at 11 A.M. A quorum being present in person or by proxy the President declared the meeting ready for action on the following agenda:

1.—Minutes of last meeting.
2.—Report of Board of Directors.
3.—Report of Treasurer.
4.—Report of Auditor.
5.—Report of Budget Committee.
6.—Report of Research Council.
7.—Report of Nominating Committee.
8.—Election of New Directors.
9.—New Business.

1.—The minutes of the last meeting having been received by all members and published in the December, 1938, issue of TEXTILE RESEARCH, they were accepted without reading and ordered filed.

2.—The annual report of the Board, as read by the Secretary and presented herein on another page, was accepted and ordered filed.

3.—The report of the Treasurer for the year ended Sept. 30 was summarized by the Secretary in the former's absence, and its accuracy having been certified by the Auditor it was accepted and ordered placed on file.

4.—The Auditor's letter certifying as to the accuracy of the books, bank records and approved vouchers of the Institute was as follows:

Report of Auditor

October 24, 1939

To the Board of Directors,
United States Institute
for Textile Research, Inc.
Dear Sirs:

I have audited the cash book, bank records and approved vouchers of United States Institute for Textile Research, Inc., for the fiscal year ended Sept. 30, 1939, and certify to the accuracy of the same.

Cash receipts, as charged, have been duly accounted for, and the payments have been substantiated by the cancelled paid cheques, bank charges and vouchers presented. The closing bank balance was reconciled at the end of the year under audit with reservation for outstanding cheques.

Respectfully submitted,
(signed) ROBERT DYSART

Report of Budget Committee

5.—Before presenting the report of the Budget Committee, of which he was chairman, Pres. Killheffer presented a comparative summary of last year's budget with the actual totals of receipts and expenses for the 1938–39 year, the latter, in every account but one, showing a cash balance instead of an estimated deficit, and that one a deficit some 75% less than estimated. Instead of an estimated deficit from all operations of $1,496 there was a cash balance of $1,368.

In presenting the budget for the 1939–40 year Pres. Killheffer stated that if co-operatively financed research is wanted by the industry the money must be provided. The estimated expenses in this report may be considered the minimum for the research projects, the magazine and for general operations; and while the estimated income is also a minimum of what should be received it may prove too optimistic.

The report having been presented Mr. Constantine moved that it be accepted with congratulations for having turned last year's estimated deficit into a cash balance of approximately the same amount. The motion having been seconded and there being no discussion excepting Dr. Walker's suggestion that the figures in the drying research account be made $300 instead of $200 in both the credit and debit columns (which was accepted) it was voted that the report, which is appended, be accepted and filed.

6.—The report of Chairman Appel of the Research Council, as appended, was ordered accepted and placed on file.

Report of Nominating Committee

7.—Chairman Besse of the Committee on Nominations then presented the report of his committee, as follows: (1) For a Director whose term is to expire in November, 1940, replacing Mr. Philip A. Johnson, resigned: William M. McLaurine, Secretary of the American Cotton Manufacturers' Association. (2) For eight Directors whose terms are to expire in November, 1942: Arthur Besse, president, National Association of Wool Manufacturers, New York, N. Y.; H. M. Chase, research director, Riverside & Dan River Cotton Mills, Danville, Va.; Daniel E. Douty, president, U. S. Testing Co., Inc., Hoboken, N. J.; Russell T. Fisher, president, National Association of Cotton Manufacturers, Boston, Mass.; Ephraim Freedman, director, Bureau of Standards, R. H. Macy & Co., New York, N. Y.; H. Grandage, vice-president, Clark Thread Co., New York, N. Y.; Edward R. Schwarz, professor of textile engineering, Mass. Institute of Technology, Cambridge, Mass.; the Chairman of the Research Council, *ex officio*.

8.—It was moved, seconded and voted: That the Secretary cast one ballot for the ticket as read, and he having done so, the President declared the nominees elected.

9.—There being no new business, the President declared the meeting adjourned.

Annual Report of Board of Directors

YOUR BOARD is pleased to report gratifying progress in our research work during the fiscal year ended Sept. 30, 1939. The promotion and conduct of research work for the industry is the Institute's major objective and function, and the following progress may be reported:

The Board has authorized the continuance for another year of the research on textile drying. This is being carried on at the National Bureau of Standards under the very able direction of the Administrative Committee whose Chairman is Dr. A. C. Walker of the Bell Telephone Laboratories, Inc. The continuance of this research is naturally based upon the satisfaction with the results obtained so far on the part of the subscribers to it.

Authorization by the Board of the start at the North Carolina State College Textile School of the research on the "Warp Sizing of Spun Rayon and Cotton-Spun Rayon."

Publication, started with the December, 1938, number of Textile Research, of the reports of the completed research on "Warp Sizing of Cotton and Filament Viscose Rayon."

The Textile Foundation has authorized the financing for completion of the study at the Wharton School on "Inventory Policies and Statistical Guides." This research was suggested by the Institute's Committee on Economic Research of which Mr. Blanchard is Chairman.

Your Board regrets that it is unable to report increase in any class of membership, although there has been a considerable increase in magazine subscriptions. The year 1938–39 was rendered a transition period in Institute history by reason of constructive changes in Contributing Membership dues, in research financing, and in accounting methods. We refer particularly to the effect upon research financing and upon Contributing Membership receipts of the revised by-laws that reduced the latter dues from $100 to $50 and required a Contributing Membership to qualify as a research subscriber.

Because the revised by-laws did not become operative until Oct. 1, 1938, all co-operators in the drying project who had subscribed prior to that date for the 1938–39 year escaped the payment of $50 dues. They numbered 26 of a total of 37 subscribers, allowing for five who paid as so-called regular contributing members. The full effect of this by-law change, therefore, was delayed until the 1939–40 fiscal year, as the refinancing of the drying project for the 1939–40 year, and the financing of the new warp sizing project for the same period, are still in progress. Upon the results of this financing depends to a large extent the future financial status of the Institute. Your Budget Committee has prepared a report that is encouraging and we hope will not prove too optimistic. It indicates that for any marked gain in Contributing Members we must rely upon having several researches in progress each of which has numerous subscribers.

However, now that we have resumed the granting of five magazine subscriptions to all Contributing Members, this class of membership should be much more attractive at $50 to those who subscribe to no research, but are willing to aid the Institute's work, than when the dues were $100, and also for the same reason to research subscribers. There are few textile companies sufficiently interested in research to take out this class of membership that do not have five representatives who could use the magazine profitably. The cost separately of five subscriptions to the magazine is $25, thus making the actual expense for dues only $25.

It is too early to evaluate accurately the effect of the changes noted upon the number of Contributing Memberships. Based upon experience thus far your Secretary is of the opinion that they will not affect research financing, but that, until we can show some outstanding research results, or can expand our magazine services, no marked increase in "regular," or non-research, Contributing Memberships can be expected.

It has been a transition period for the magazine because, as of Oct. 1, 1938, it was given a separate financial entity, this obliging it to carry all general expenses fairly chargeable to the magazine account. The only offsetting new income made available to the account was that to accrue from the privilege of publishing paid advertising. With income from two advertisers, a moderate increase in subscriptions and the continued support of the Textile Foundation, it came through last year with a deficit of only $270.06. Until such time as the increased size and services of the magazine permit the subscription price to be the same as annual membership dues, or $10 a year, we shall have to seek additional advertising revenue to keep the magazine out of the red. Its advertising value, by the way, will be enhanced the coming year by a largely increased mailing list.

We have entered upon the Institute's tenth year with definite realiza-

tion of the fact that our progress since the Institute's organization and incorporation in November and December, 1930, respectively, has been far from realizing the hopes of the founder directors and members. While substantial progress has been made it is disproportionate to the time and energy contributed by your Board, your officers and active members, and by those organizations and institutions which have co-operated with us.

We are confident that we have made available to the industry services that are needed, yet our membership plus our magazine subscriptions fail to substantiate this assertion.

Your Board feels that at the completion of the tenth year of the Institute we should be able to justify our existence in some more tangible way than has been the case up to the present. If we fail to render services valuable enough to the industry to justify their supporting our work, it is the feeling of your Board that the whole question of our existence should then be re-examined and appropriate action taken.

Appreciation of Contributed Services. Your Board desires to record its appreciation of all services contributed during the fiscal year by non-member individuals, organizations and other bodies, notably the following:

The Textile Foundation for completing the financing of the two-year study at Wharton School of Finance and Commerce on "Inventory Policies and Statistical Guides," and for renewing for the current fiscal year its publication agreement.

The National Bureau of Standards and the North Carolina State College Textile School for making available for our scientific researches their facilities and the co-operation of their staffs.

The Corn Industries Research Foundation for its subscription of $1,000 to the warp sizing research, and for making available the services on the latter's Administrative Committee of Dr. W. E. Yelland.

We also record our appreciation of the valuable services contributed by members of the Committee on Economic Research, and of the Administrative Committees for the drying and warp sizing researches.

Annual Report of Research Council

IN REPORTING for the Research Council, I shall give you a brief statement of the status of each of the researches under our jurisdiction. Dr. Walker, chairman of the Administrative Committee for the Drying Research, will present a more detailed report on that work immediately following the luncheon and Mr. Blanchard will report then on the study of "Textile Inventory Policies and Statistical Guides," which is being undertaken at the Wharton School with the support of the Textile Foundation.

Old Warp Sizing Research: This research was terminated over a year ago. The results, which have been reported only to the subscribers in accordance with the ruling which prevents their disclosure for one year, are being published in "Textile Research" as rapidly as can be. Seven papers have appeared during 1938–39.

Drying Research: Steady progress has been made in the drying research and three reports have been sent to the subscribers during the year. The first was a final report on the work of the first year. The second covered

the effects of drying at different temperatures and humidities on the physical and chemical properties of yarns made from all of the principal fibres. The third was concerned with the effects of drying on the dyeing behavior of yarns.

The value of this work to the subscribers is indicated by the action taken by them at a meeting held at the National Bureau of Standards on June 16. They asked that the work be continued for another year starting Oct. 1, 1939, and agreed upon a program. The program includes studies of the practical drying of packaged textiles and the influence of finishing materials in drying. The packaged dryer and necessary measuring and recording instruments have been installed and the work is in progress.

The present program is expected to be completed and the project terminated by Oct. 1, 1940.

Economic Research: On recommendation of our Committee on Economic Research, the Textile Foundation appropriated an additional sum of $15,000 for the study "Textile Inventory Policies and Statistical Guides." The total cost of the study, $30,000, is now available for the work which will require about two years for completion.

New Warp Sizing Research: As a result of the favorable action of the open conference on this project held a year ago, the Council has taken all possible steps to facilitate the start of the work when the necessary financial support is forthcoming. An administrative committee was appointed. It consists of Mr. Carl R. Harris, manufacturing engineer, Erwin Cotton Mills Co., Durham, N. C., Chairman; Dean Thomas Nelson of the North Carolina State College Textile School, Raleigh, N. C.; Dr. W. E. Yelland of the Research Department, Corn Products Refining Co., Edgewater, N. J., who was director of the Institute's previous sizing research. The Institute and the subscribers to this project are fortunate in obtaining the services of a committee so well qualified to supervise the project.

The North Carolina State College Textile School was selected as the place for the study. It is prepared to furnish the necessary facilities, including a new slasher and a weave room with controlled atmosphere.

A tentative program for the work was prepared. It contemplates a practical study of the sizing of spun rayon warps and of warps composed of mixtures of spun rayon and cotton.

The slasher will be equipped with instruments for measuring, recording, and controlling the factors which influence sizing, all of which will be varied systematically and the effects studied. Special attention will be given to the weaving of the warps, particularly with respect to relative humidity and temperature of the air. The properties and performance of the sized yarns will be studied.

Proposed Study of Wool Manufacturing Processes: The Council was authorized to conduct an open conference for the purpose of determining whether a study of wool manufacturing processes should be undertaken under the Institute's co-operative plan. This conference is to follow the annual meeting.

Treasurer's Annual Report

For Year Ending Sept. 30, 1939

General Funds

Receipts		*Expenses*	
Oct. 1, 1938 Balance	$ 110.43	Office Expenses & Misc.	$1,123.67
Annual Memberships	1,640.00	Salaries 2/3	3,000.00
Contributing Memberships	2,600.00	Rent 2/3	240.00
Miscellaneous	433.80	Balance Oct. 1, 1939	420.56
	$4,784.23		$4,784.23

Magazine

From Textile Foundation	$2,883.38	Printing magazine, reprints, misc.	$3,064.21
Advertising	426.30	Salaries 1/3	1,500.00
Subscriptions, etc.	1,104.47	Rent 1/3	120.00
Deficit Oct. 1, 1939	270.06		
	$4,684.21		$4,684.21

Warp Sizing

Oct. 1, 1938 Balance	$1,155.20	M. I. T.	$ 385.29
Advance payments for new study	300.00	Balance Oct. 1, 1939	1,069.91
	$1,455.20		$1,455.20

Drying

Oct. 1, 1938 Balance	$2,619.31	Salaries	$3,200.00
Co-operators	775.00	Stenog. & Misc.	120.99
Insurance dividend	7.81	Compensation Insurance	33.04
Advance payment 1939–40	100.00	Balance Oct. 1, 1939	148.09
	$3,502.12		$3,502.12

Summary

Balance General Funds	$ 420.56
Warp Sizing	1,069.91
Drying	148.09
	$1,638.56
Less: Magazine Deficit	270.06
Cash Balance Oct. 1, 1939	$1,368.50

Invested Funds

Oct. 1, 1939 Balance in Salem Savings Bank	$1,301.43
Oct. 1, 1939 Balance in Sales 5c Savings Bank	1,324.63
	$2,626.06

Budget for Fiscal Year 1939–1940

General Operations

Income		*Expenses*	
Balance Oct. 1, 1939	$ 420.56	Salaries 2/3	$3,000.00
Transfer from old Warp Sizing account by vote Nov. 1938	455.00	Rent 2/3	240.00
Memberships estimated at		Office, General & Misc.	1,500.00
80 Contributing	4,000.00		
180 Annual	1,800.00		
	$6,675.56		$4,740.00

Magazine

Textile Foundation	$2,700.00	Deficit Oct. 1, 1939	$ 270.06
Reprints, etc.	300.00	Salaries 1/3	1,500.00
Subscribers	1,040.00	Rent 1/3	120.00
Advertising	960.00	Printing	2,700.00
		Reprints, etc.	300.00
	$5,000.00		$4,890.06

Drying Research

Cash balance Oct. 1, 1939	$ 148.09	Research associate	$3,200.00
34 subscribers	3,400.00	Stenog. & misc.	50.00
Insurance refund	6.67	Insurance	33.34
Appropriation from interest fund for apparatus	300.00	Apparatus	300.00
	$3,854.76		$3,583.04

New Warp Sizing Research (South)

Cash balance Oct. 1, 1939	$ 614.91	Estimated Expenses	$3,800.00
27 subscribers	2,700.00		
Corn Industries Research Foundation	1,000.00		
	$4,314.91		$3,800.00

Recapitulation

Estimated Income	$19,745.23	Estimated Expenses	$16,913.10

The Luncheon Addresses

As previously noted the President's annual address led the speaking program following the luncheon, after which President Killheffer introduced Chairman Franklin W. Hobbs of the Textile Foundation who spoke briefly of that body's work, and called upon Dr. Robert E. Rose to report on the Foundation's scientific research, and then upon Fessenden S. Blanchard to outline their economic research work.

President Killheffer then asked Chairman W. D. Appel of the Research Council to report on Institute research projects, and this he did briefly for the new warp sizing study, and then introduced Dr. A. C. Walker, of the Administrative Committee for the textile drying research, to report on that project.

President's Annual Address

By DR. ELVIN H. KILLHEFFER

AS we complete one year of Institute activity and look forward to the beginning of another, it is well to take stock of our situation.

Nine years have now been devoted to our work of encouraging, and, where possible, leading the textile industry to undertake research co-operatively. There is reason for gratification at what we have accomplished as well as a feeling of deep dejection because of our failures.

There have been from the first very strict financial limitations. No research worthy the name can be conducted without money and the amounts we have been able to raise have not been large. Nor can there be any very widespread research propaganda among the units of the textile industry except at considerable cost.

Nevertheless, there is much more research mindedness in the United States textile industry today than there formerly was. For some years before the organization of this Institute and while I was president of the American Association of Textile Chemists and Colorists, I advocated co-operative textile research at every opportunity. Not that I had discovered anything new but because I was convinced of the great need itself and for the further need of constant repetition of the pleas for it. My textile friends probably suspected at times that I was trying to sell them something. I was—but it was an idea I wanted to sell. Many others were advocating the same idea and this Institute was organized in the hope that it would be the rallying point. It was intended to be an organization of the textile corporations as distinct from the organization of their technical employees in the A. A. T. C. C.

As between fundamental and applied research, most progressive mills are doing some of the latter at all times. Few if any, however, can do fundamental work. A co-operatively financed job is entirely possible and

I think highly desirable. Our friends in Brifain think so, too, and as you know are so engaged.

In the United States the idea has not been sold to the point that the industry as a whole will support it. Here our Institute has failed. What success we have had is rather in the field of applied research and even here the necessary financial support is very difficult to obtain. Naturally, we hope that the results of some of these applied researches will be so challenging as to command financial support not only for their continuance and expansion but more importantly for the undertaking of fundamental research, which is the foundation on which subsequent applied research is built.

We have definitely accomplished one thing and this is an encouraging step. We have procured co-operative financing. At first the Textile Foundation contributed half the cost and latterly we have raised all the money for such studies as we have made. The present important research on Drying is so financed as will be the new Warp Sizing study shortly to be begun in North Carolina.

The view has been expressed that Applied Research should be the field of activity for this Institute. As justification for this view the present support of fundamental studies by the Textile Foundation is pointed out. In my judgment this position is not well taken. However excellent the work now supported by the Foundation, there is, according to my understanding, no permanence to it. When the money is gone the program comes to an end. This must be true if the money is used to support fundamental research.

If fundamental work ceases, there ceases also the constant flow of new facts on which applied research is based. Besides, this Institute was created to promote the idea of fundamental research by and for the textile industry and we should not change our objective because of lack of success in attaining it.

Two years ago I made a proposal. The meat of that proposal was the putting together of a fund large enough to command respect in the first place. In the second place it was not to be available unless and until the textile industry would pledge itself to yearly contributions to the project over a period of years.

Mr. Fuller E. Callaway, Jr., last April proposed a finance plan based on voluntary assessments of the textile mills. He suggested 1% of net invoice values to produce about $25,000,000 a year. He not only suggested it, he also offered to contribute his share on that basis if other mills would join him.

My own proposals of some years ago of a self-assessment of 1/10th of one per cent were modest by comparison and yet would yield an adequate sum of something over $2,000,000 yearly.

Perhaps the Textile Foundation could succeed where we have failed. A conference could be called including the officers of every textile manufacturers association, including, of course, Mr. Callaway. If as a result a scheme of self-assessment could be set up and made to function, a comprehensive research program would be assured.

Naturally, if such a conference were called, an outline of program should be ready for presentation. I modestly suggest a program modeled on the one I suggested two years ago as providing the maximum benefits for all participants.

We have succeeded in some things and failed in others. As to the future we have no pride of place. Whether we lead or follow is of no consequence. Our sole objective is to hold aloft the torch, promoting in every way possible the idea for which we stand.

Textile Foundation Research

President Killheffer: The Textile Foundation is proceeding to finance various fundamental researches, as I understand the picture, and we have with us today, and feel highly honored that he is here, Mr. Franklin W. Hobbs, who is chairman of the Textile Foundation. I want to ask him to address you and I believe he also will introduce others who are present and who have a part in the program of the Foundation. In that way we can all get a better understanding of what the Foundation is doing. Mr. Hobbs.

Remarks of Mr. Hobbs

MR. PRESIDENT AND FELLOW MEMBERS: I have been asked to introduce two men who have done much for the Textile Foundation. I would like to say, however, that it is perfectly true as Dr. Killheffer has said that the program as now outlined and being carried out by the Textile Foundation will mean that its funds will be gone in about ten years. It seemed to us that it would be far better for the industry to expend a comparatively larger sum each year for the next ten years than it would be to simply expend a comparatively small part of the capital that is continually growing smaller. Furthermore, we felt that the expenditure of about three times as much annually during the next ten years ought to prove of some value to the industry, and if at the end of that ten years and as a result of the work in research that had been carried on the industry hadn't then waked up it would be just too bad and too late to save them. It is up to the industry to do something during that period of ten years. I would add that the Act of Congress creating the Textile Foundation empowered it to accept any and all donations to its present capital, but to date no one has stepped forward to offer us anything.

It is a very pleasant duty today to introduce two of the men who have been helping the Foundation in some of its work. We have been extremely fortunate in the character of the men who have been willing to give their time and services to the various parts of the work that the Foundation is trying to carry on. We have in charge of what we call our scientific research a man who I would like to call on now who has given us of his time and talents and who is an outstanding man in his line of work. Dr. Rose.

The Foundation's Scientific Research

By DR. ROBERT E. ROSE

TWO YEARS AGO the advisory committee was called into consultation by the Directors of the Textile Foundation to discuss the best way to make the research underwritten by the Foundation as productive as possible. It was felt that the period up to then was very well spent in bringing

young men into this field and in making possible work of a more or less basic nature in several institutions, but it was realized that the time had come for something more than a support of research conducted by others.

As a result of that conference Dr. Briggs, Director of the National Bureau of Standards, discussed the whole matter with Dr. Emley and then drew up a memorandum to the Textile Foundation. In this document he said, "the projects so far undertaken have in the main been directed at specific problems. To use a military analogy, they represent individual sallies rather than a planned, concerted attack on some sector. I believe the work of the Foundation has reached the stage where the latter procedure gives promise of greater returns."

Dr. Briggs then went on to recommend two projects; one a basic research on wool fibres and the other a basic research on cotton. Further on he said, "The Foundation should maintain direct control of this work. This can be done through an advisory committee." The plan was adopted by the Board, the work to be done at the National Bureau of Standards, where Dr. Milton Harris, under Dr. Emley's direction, had already done excellent work on wool. The budget was not to exceed $40,000 annually, and to give the necessary permanence was to extend over five years. The advisory committee, consisting of Mr. Eavenson, Dr. Emley, Dr. H. DeWitt Smith, Dr. Hugh Taylor and later Dr. Winter, with myself as chairman, was appointed and went to work.

The most essential matter was the selection of personnel. I will not bother you with details but I shall tell you with all due modesty that the committee consider they have been remarkably successful in securing the services of a very fine group—a group that is so devoted to research that its members look not so much to their salaries but to the work they put out as cause for contentment. It has taken time to organize; the work was only started in July of last year and the last important addition to the group joined the staff a few months ago.

The advisory committee is in the friendliest and closest possible accord with the Board of Directors of the Textile Foundation. The arrangement is the following: The fellows are employees of the Textile Foundation. They work under the general supervision of Dr. Emley. He not only takes a very active part in the direction of the work but he also acts as manager of the relations of the group to the National Bureau of Standards and the other U. S. laboratories. His aid has been indispensable and he has given of his time most generously. The facilities furnished free and the co-operation of other groups of research men at the National Bureau of Standards double the value of every dollar spent by the Foundation.

The group of research men is under the leadership of Dr. Milton Harris. The work is divided into two primary classifications—research on protein fibres and research on cellulosic fibres. Dr. Patterson is investigating the wool fibre, particularly the breaking of the -s-s- cross links. He has some surprising results already; these will explain many anomalies very well known to the practical man and seem to point to another and distinct method of influencing the properties of wool. Mr. Rutherford is busy exploding the many ingenious explanations that have been advanced to account for the difference between soft and hard silk. Dr. Steinhardt is busy on the titration of wool, a subject that has been handled before but never from his point of view. He has already many entirely novel theories supported by very rigorous experimental facts. These not only possess an

absorbing scientific interest but they will sooner or later lead to the modification of mill processes.

Mr. Sookne is determining the electric charges carried by protein fibres when broken down into fine fractions of their former magnitude. His work and that of Rutherford and Steinhardt is supported by work done from the standpoint of the pure physicist. Dr. Lewis, the physicist, has had a long experience in fibre work. He is a very recent member and has had no time to do more than start his program of using birefringence as a tool. The work on cellulose is in the hands of Dr. Whistler. Already this has given us a finer analytical method than any other for the determination of the non-cellulosic material of cotton fibres. If we are to have real information, it must be founded on just such controllable quantitative methods. Dr. Hock, our morphologist, is welding Whistler's work into the structural design we have of the fibre as a product of a life process. Dr. Hock has just begun.

Dr. Gleysteen is doing basic work on the mechanical alteration in fibre properties, their swelling, etc., that fits very neatly into the co-ordinated plan by which we are trying to advance into the territory of the unknown in the structure and properties, both physical and chemical, of textile fibres.

In addition to the work of this very close-knit group, all of whose valuable members I have no time to mention, there is work being done outside the Bureau: at M. I. T., Prof. Schwarz is using extremely refined methods to measure the physical properties of fibres, and Dr. Bergmann at Yale is progressing with his study of the physiology of chemistry of silk secretion.

I do not think that I am over-optimistic in saying that the character of the work being done by all these workers and the importance of their results will some day be regarded as classical.

The Foundation's Economic Research

Mr. Hobbs: In addition to scientific research the Foundation is conducting a great deal of work for the textile schools which has for its objective the improvement and broadening of their curricula. A survey indicated that there was a great need for the assembling of teaching materials covering the application of the principles of economics to the textile business—merchandising as well as manufacturing. A series of text books of this character was prepared by the staff of the Wharton School of the University of Pennsylvania, and complementary and basic to this the Foundation has authorized and financed two economic researches at the Wharton School both of which were suggested by the Institute's Committee on Economic Research. I am very glad that we have here today the Chairman of that Committee who is also a member of our Advisory Committee on Economic Research. He is going to tell you a little about that work. The charter of the Textile Foundation states that it is to carry on scientific and economic research for the benefit of the textile and allied industries, so we can work on either or both. Mr. Blanchard.

Mr. Blanchard's Report

I APPRECIATE a good deal the opportunity of telling about the economic research program. As you know, the first important economic study on "Vertical Integration in the Textile Industries" was completed and the results published in June, 1938. That has already been distributed to over a thousand different organizations. It had a very wide circulation and in a few cases has very definitely influenced the thinking of a number of textile companies in their programs. About a year ago the Committee on Economic Research of the Institute recommended to the Textile Foundation another study. The subject was "Textile Inventory Policies and Statistical Guides." The industry had just taken a bad licking because it hadn't sized up the situation accurately. There were inventory surpluses all along the line. One of the major purposes of this study is to find out whether there are any danger signals which will be a guide and reduce repetition of this sort of thing. About a year ago the Foundation approved a very generous appropriation for the study which was later enlarged. Approved by presidents of a number of leading textile associations, Mr. Besse was particularly helpful in working out this project. The Wharton School of the University of Pennsylvania started the job about February, 1939, and they have already interviewed over 150 people—dealers in raw cotton and others all along the line; have studied all available statistics showing the trend of stocks in each different stage between the raw material and finished product, particularly from the mills on, trying to find what the trends are and what use of them they can recommend, having in mind the possible organization of those statistics into special guides which will help us as textile men to avoid many of the mistakes we have made in the past.

All I can say about results is that they are hard at work at the Wharton School, which did such a swell job on the previous study. They have met with fine co-operation from all branches of the industry. Their work is largely along three lines: Inventory trends, inventory policies, and trying to work out what inventory guides should be; not merely a study of statistics but of case history; hoping to find companies which did a poor job in sizing up inventories and to find companies that did a good job; and in the latter cases as to whether there were some danger signals that they had in their minds. Out of all that they hope, in about a year from now, to make a report which, unless I am very much mistaken in the light of what they have done before, will be a very valuable contribution. In closing I would like to express the thanks of our Committee on Economic Research for the very valuable support of Mr. Hobbs and other members of the Textile Foundation which made this study possible.

Research of the Institute

Discussion of the Textile Foundation's research program having been completed President Killheffer asked Chairman Appel of the Research Council to report on the Institute's work, and the latter, after briefly referring to the new warp sizing study as follows, called upon Dr. Walker to describe the work of the textile drying research.

The New Warp Sizing Project

THE research program of the Institute was reported on this morning and I see no reason for repeating it. Work on the various projects is in charge of administrative committees. They are really responsible for the progress that has been made. You have heard about the economic research and you will hear in a moment about the drying research.

As to the new warp sizing research, I may say that it was authorized in accordance with the open conference that we had a year ago. Plans are now very well developed. It will be carried out in the South at North Carolina State College Textile School which has excellent facilities for the work and has kindly placed them at our disposal. We have a very able Administrative Committee for the work in Mr. Carl Harris, Dean Nelson and Dr. Yelland. We have had the latter's advice and that of Mr. Emley and Mr. Chase in drawing up the program. This study is going to be a very practical one, taking the warps right through the slasher and the weaving under controlled conditions. The drying research is in charge of a committee headed by Dr. Walker and I am going to ask him to say something about it.

The Textile Drying Research

By Dr. A. C. WALKER

DURING the first two years of the work of the Drying Research program valuable experimental data were secured on two generally important phases of the problem. The first year's work consisted primarily of determining equilibrium moisture content data for the various types of textiles, over as wide a range of relative humidity as possible at each of several temperatures from 100 to 300° F. Our results have been checked, where possible, with other data in the literature and we have satisfied ourselves that our data are not only reliable but of sufficient value to justify their inclusion as standard reference material in the International Critical Tables. These data give information which any textile manufacturer can use where he has need for controlling drying processes, and I think there is plenty of need in this direction.

The second year's work was directed towards determining the effect of heat and humidity together upon the important physical and chemical properties of these textiles in the pure state, and we succeeded in that, I think, beyond our expectations.

We found as a rather consistent generalization that heat and high humidity together have a more harmful effect on the textile fibres than when the heat is applied to relatively dry material. These results have been rather surprising. Some textile manufacturers may have had some inkling of this effect before, but the general principles, which we can express rather comprehensively, have not been well known in the industry. Our tests included several different useful measures of these effects.

We have recently had placed at our disposal experimental package drying equipment, and recording apparatus for measuring and controlling not only temperature but humidity also. During the current research year we expect to study certain of the properties of textiles, in the form of commercial lots, to find out what is the effect of temperature and time of drying under various humidity conditions; to find out how long it takes

to dry packaged material and to determine the effect of previous processing and commercial impurities, such as sizing, when heated during drying. In addition, we have attracted the interest of certain manufacturers of drying equipment used outside of the textile industry where some new drying principles are involved. Some of these principles appear to deserve some investigation and we hope to carry on some of this during the coming year.

We had a conference this morning before this meeting took place, in which one of these companies told us of the general principles of drying by means of vacuum and heat which is supplied uniformly through the body of the material under vacuum conditions in a way which was not possible before.

We are planning to go into that rather definitely and thoroughly, and before we are through I think we will be in a position to give you authoritative information on ways of drying textiles that may be a distinct improvement over what has been done before.

Therefore, to recapitulate briefly, we have provided scientific information which will enable any company which has the trained personnel to use information regarding the properties of moisture absorption of textiles.

We have indicated directions for chemical tests and mechanical tests on materials which have been dried under different conditions, so that those tests and that type of treatment may be used to improve certain manufacturing operations; and, thirdly, we are studying new pioneering methods of drying which most other industries don't know anything about at all.

So it looks as though we have broadened our investigations beyond the initial fundamental objective, in certain practical directions, which to my mind is a better integrated form of research job than we had hoped to do when we started.

"A Symposium on Color Tolerance"

THE papers presented at the eighth annual meeting of the Inter-Society Color Council, jointly sponsored by the American Psychological Association, and held in New York Feb. 23, 1939, have been reprinted in a 64-page booklet from the July issue of the *American Journal of Psychology*, and a limited number of copies can be had at 50 cents each. For such purchase address: Inter-Society Color Council, P. O. Box 155 Benjamin Franklin Station, Washington, D. C.

The papers are largely the contributions of psychologists in recognition of the fact that color tolerance is in large measure a psychological matter; however, they are limited closely to established facts and techniques. Of particular interest to textile men is a reprint accompanying the booklet which reports a dialogue between Mr. Dyer, who dyes fabrics for automobile upholsteries, and Mr. Meter, the "pure" physicist, on practical application of "The Physics of Color Tolerance." This dialogue, by the way, was reprinted in the *American Dyestuff Reporter* of Aug. 21, 1939.

"Wool Fibre Damage in Processing" Discussed at Open Conference

The conference resulted in a unanimous vote by those present who are engaged in wool manufacture that a study of the subject discussed is worthwhile, and that the Institute be requested to develop ways and means of conducting it.

It was suggested that the study of damage caused by heat, humidity and other factors involved in drying might be studied in connection with the Institute's textile drying research, provided money for hiring an assistant can be raised.

A committee will be appointed by Chairman Appel of the Research Council to study the suggestions and the conference papers and discussion, and to report as soon as possible on a research program and the method of organizing, financing and conducting it.

NO MANUFACTURER likes to be told that his methods of processing are seriously damaging his raw material, yet a representative group of woolen and worsted men who attended the Institute's open conference and discussed "Damage to the Wool Fibre in Processing" not only made no effort to refute this reflection upon their technical skill, but reasserted its correctness and expressed the hope that something might come out of the conference that would result in reducing or eliminating this type of wool fibre damage.

True, one of those present declared that, notwithstanding this fibre damage in processing, "there isn't a suit in this room that will be worn out by the man who has it on." Yet this speaker was one of the strongest advocates of research on the problem of processing damage to the fibre. Undoubtedly he agreed with other speakers who emphasized the outstanding ability of the wool fibre to withstand much of the terrific punishment to which it is subjected by the manufacturing processes.

Since the wool fibre is able to stand much of the punishment due to processing, and manufacturers are able to produce woolens and worsteds of acceptable wearing quality, the layman might consider the subject of this conference of no vital importance; undoubtedly some of the manufacturers who failed to attend regard it similarly, or are resigned to fibre damage as something that cannot be prevented.

Possibly those who were present and took part in the discussion are over-optimistic, but they believe that there is much existing scientific knowledge which when practically interpreted will reduce or eliminate certain causes of fibre damage, and that additional chemical and physical research properly directed and conducted will solve eventually the other problems.

It is not the production of higher quality and better wearing products that they are vitally concerned about, but the marked reduction in manufacturing costs that will result automatically from reduction of wool fibre damage in processing.

The Conference Objectives

Wool is one of the highest priced textile raw materials; the wool industry's wage and other manufacturing costs are higher on the average than for any other textile industry. A research project whose objectives are to lower both of these costs, and at the same time to produce a better product has elements of appeal that can seldom be claimed. Had it been possible in the advance conference publicity to state that methods of reducing manufacturing costs due to wool fibre damage were to be discussed, it is a safe bet that the conference room would have been too small for the audience. While all of those present may have had in their minds this possibility of reducing costs, it was not referred to in the formal papers and by only one of those who took part in the discussion. That it was an outstanding factor of interest, however, was plainly evident.

Opening Remarks of Chairman Appel

W. D. Appel, Chairman of the Institute's Research Council, acted as presiding officer at the conference, his opening remarks being as follows:

"When a new subject for research is under consideration by the Institute, it has become customary to hold a conference open to all who may be interested, in order to develop a clear conception of the subject and to find out what scientific study of it is likely to produce worthwhile results.

"Today, the meeting is for the purpose of discussing the need for a study of wool manufacturing processes from the standpoint of the effects upon the properties of the fibre. Much new information about the chemistry and physics of wool has become available in the last few years as a result of laboratory research both here and abroad.

"The question is raised: 'To what extent has this academic knowledge been applied in the improvement of woolen and worsted processing? Is a resurvey of manufacturing processes now in order and, if so, can a practical plan for co-operative research be worked out?'

"In order to open the way for general discussion from the floor, we are going to call on three speakers. First, we will ask Dr. Milton Harris, director of research for the Textile Foundation, to speak about recent developments in our knowledge of the chemistry of wool."

Dr. Harris' Talk a Preview of Official Reports

The work that is being done by the Textile Foundation at the National Bureau of Standards under the direction of Dr. Harris was briefly referred to by Dr. Rose at the luncheon meeting. That involving the work on titration of wool by Dr. Steinhardt, and that of modifying or influencing the properties of wool by Dr. Patterson was explained in considerable detail by Dr. Harris. He indicated that some of this work has progressed far enough to show the possibility of practical applications, and that other investigations have opened up new lines of scientific attack that give promise of producing valuable practical results.

Those who had the privilege of hearing Dr. Harris obtained a preview of research work and results that will not be available to others until the progress reports of these Foundation researches are released in the near future for publication in this magazine. When published, complete scientific data will be given, whereas Dr. Harris' conference talk was merely an outline report. In one respect this talk was more informative or thought-compelling than the average scientific paper or report, in that he indicated possible practical applications of existing or anticipated research findings.

The papers by Mr. Werner Von Bergen, Director, Research and Control Laboratories, Forstmann Woolen Co., and by Mr. Rinaldo A. Lukens, vice-president, Continental Mills, Inc., which follow are published complete. Both of these gentlemen, as well as Dr. Harris, were subjected to considerable questioning during the discussion period, and certain of this and their replies will be found in the outline report of the discussion.

New Knowledge of the Physics and Microscopic Structure of Wool

By WERNER VON BERGEN *

WE have to admit our ignorance, from the scientific point of view, of many of the essential fundamentals underlying commercial practice in woolen manufacturing. Naturally I look at these problems more from the practical viewpoint of a mill man rather than from the purely scientific. The present mill processes are based on practical experience or empirical formulas. Up to 1920, science was very slow in checking up the facts of this practical experience. The economic conditions following the war caused manufacturers to seek ways and means of producing their goods at lower costs and with greater efficiency. In doing this they realized the lack of scientific knowledge of their product and the need for fundamental wool research. We must admit that the success of the rayon industry played an important part in bringing this lack to the fore.

We can be proud that the strivings which were made in the last twenty years have already brought many valuable results, especially in the determination of the main properties making up the quality of wool, such as fineness and length. Considerable progress was also made in sampling and scouring raw wool for shrinkage determination.

Histology of Wool Fibres

The minute structure and external shape of wool fibres were established by the classic researches of Natusius in 1864. In this country the classic work on American Wools was done by McMurtrie in 1880–1886. Since then not much was added to the knowledge of the microscopic structure of the wool fibre and about the various animal cell layers in its make-up. We are still at a loss to explain the force which holds together the cortical cells making up the main body of the hair. According to Froehlich there is a liquid present between the plasmatic cells as they exist in the root of the fibre. In the process of growth these cells change from a globule into the

* Director, Research and Control Laboratories, Forstmann Woolen Co., Passaic, N. J.

long flattened shape with progressive cornification and contraction. The liquid present between the original cells may act as a cementing fluid. McMurtrie observed that these cortical cells are more or less twisted. Two years ago the same observation was made by Reumuth, who claimed it to be a new discovery. Through the twist formation the cells seem to fit into each other, thus holding together very much as the pieces fit into each other in a jigsaw puzzle. The smallest visible elements forming these cortical cells are still unknown, and research similar to that of Miss Farr on cotton is still an open field.

The importance of keeping intact the protective scale layer, or epidermis covering the cortical layers, was made clear by recent work of Harris and his colleagues. It has been shown that merely by mechanical damage, such as hitting the fibre with a hammer, the wool fibre is rendered far more susceptible to bacterial damage. Also Royer, in a talk before the American Association of Textile Chemists and Colorists in Boston last September, was able to show the importance of the epidermis cell in the dyeing process. The practical experience that over-scoured wool from which the last trace of fat has been removed, shows considerable loss of strength and spinnability, was scientifically proven by Mark. Over-extraction causes numerous empty spaces or vacuoles to appear between the cortical cells.

Quality of Wool Fibres

The main characteristics making up the quality of the wool fibres are fineness, length and strength. This is recognized in the trade especially because the first two are the decisive factors in setting the price of wool. For example, the average price difference between the various United States grades, based on the fineness only, is about 7¢ per pound. The price difference between a wool which measures in length over 2 in. and wool of the same grade measuring less than 1¼ in. is 10¢ per pound.

As you know, the present commercial practice or routine grading of wool is done by men of long experience who by merely handling and observing the material, assign it intuitively to its proper grade. Such estimating has many sources of error, principally based upon the mental and physical qualities of the sorter. At the same time, other factors, such as light, color and luster of the hairs, considerably influences the result. It was therefore only natural that for more than a century and a half scientists working with wool should have attempted to replace the system of manual sorting by a system of measurements in a scientific manner.

In the last ten years the largest achievements were made in this direction. We have not replaced, and I think we never will, the manual sorting, but we have developed methods which serve as an accurate control of the manual work. For semi-manufactured products such as wool top and yarns and in finished pieces the new methods are generally far more accurate than any manual appraisal.

In July 1926 the U. S. Department of Agriculture promulgated the official standards for the United States for wool and top. They were selected on physical inspection only by a mixed group of American industrialists, United States government officials and English officials. If I am not mistaken, Mr. Hobbs of the Arlington Mills was also a member of this group. After the adoption of these standards, the scientists had for the first time a foundation upon which to build an accurate method of measurements. The most astonishing results were found by Winson, namely that, for the range

of the selected tops, the progress scale of fineness ascending from 48s to 80s quality is in geometric progression. A similar relationship was found for the French, German and Italian standards, and it proved that the fundamental basis underlying wool sorting was the same in all countries. This fundamental basis is a psycho-physical law known as the Fechner-Weber law, which made it clear that the eye, in the physical sense, rather than the touch is the paramount factor in wool sorting.

Measuring Methods

As the result of the enormous amount of research on wool measurements, following Winson's discovery, we have today three methods suitable for determining the grade or fineness of the wool fibre, namely: width method,* cross-section method * and the gravimetric method. Of the three, the first two are now in daily use in numerous mill and testing laboratories throughout our country.

That this was possible has to be accredited to the united efforts of the Wool Section of the A. S. T. M., the Top Committee of the National Association of Wool Manufacturers, and the officials of the U. S. Department of Agriculture. Special credit is due to the work done by Dr. Hardy and Mr. Kruegel.

The most important result of that work is that the government consented to a revision of the present top standards, not only replacing the seven grades of the present standards through domestic tops, but also introducing a new grade, Quality 62, long considered in the trade as an American standard. For the use of this new top standard, which will become effective Jan. 1, 1940, the U. S. government has specified two methods:

(*a*) Comparison with the practical forms of the official standards of the United States for grades of wool top.

(*b*) Measurement of the fibre diameter in microns prescribed by the Bureau of Agricultural Economics, Wool Marketing Section. With this section specifications are given.

At present the selection of these new standard samples is in progress. The selection is made on the basis of microscopical measurements by the Wool Section of the U. S. Department of Agriculture, having Werner A. Mueller in charge, in co-operation with different mill laboratories. We can regard this as a milestone in the history of wool research.

These methods are not only valuable for the manufacture of woolens and worsted goods, but they are also of outstanding value for the wool breeder. The Bureau of Animal Industry, for example, is selecting pure bred animals on the basis of such measurements. The methods are also used to establish the commercial fineness of the specialty hair fibres: Mohair, Cashmere, Camelshair, Alpaca and Vicuna, as reported in the American Wool Handbook.

Length

The influence of fibre length in the manufacturing process is well known. The methods used for determining this factor are all of recent date.

* A. S. T. M. Standards on Textile Materials, D 419–37.

Up to two years ago the American wool industry depended on European instruments for length determination, especially in tops, but now the Wool Section of the A. S. T. M. has in their book a standard method for length measurement * based on an American-made instrument. This new method was also adopted by the New York Wool Top Exchange and is used in evaluating commercial tops. The method is used for daily routine work in most of the large woolen mill laboratories.

In using this method it was found that the condition under which tests are made has a decisive influence on the average length. When testing under standard conditions, 70° F. and 65% R. H., the average length of a top of 14–15% moisture may be from 2–6% higher than top tested under normal room conditions with an average moisture content of the top between 8–10%. The variation in length is an excellent criterion for the uniformity of the top and reflects the length uniformity of the raw material used. Very good tops show a variation around 30%, average top around 35%, and below average 40% and more.

Strength

Satisfactory methods for the determination of strength are available and numerous instruments for testing individual fibres, staples, yarns and fabrics are on the market. I think the greatest lack of scientific data is that on the average strength of the individual wool fibre, in regard to their origin and grade, and as to the change of the original strength during manufacturing processes. Numerous attempts have been made in this field, but none comprehensive enough to give a good picture.

Importance of the Moisture Content

In May, 1936, this Institute held a conference on textile drying. The result was that a comparative study on the drying of textile material was undertaken, which, under the leadership of Dr. Walker and Mr. James Wiegerink, the research associate, has brought out some new and important information of an outstanding nature, not only for wool but also for all the other major fibres. It is not the purpose of my talk to go into detail in this respect, as Dr. Walker and Mr. Wiegerink are much better equipped to do so, but I would like to bring out just a few points which Mr. Wiegerink made clear to me in a recent letter.

The pre-history of a wool is very much responsible for a certain moisture content. It affects tremendously the ability of the wool to absorb moisture. For example, when a sample of wool is exposed to 65 R. H., it will absorb 16% moisture at 96° F., when approached from the wet state, but less than 14% at 65% R. H., when approached from the dry state. Therefore, when moisture determinations are made it is possible to obtain the moisture content values between 14 and 16%, at 65% R. H., 96° F., depending upon the pre-history of the wool before conditioning.** Some Russian scientist brought out that with each additional mill process, especially of a chemical nature, the affinity of the wool fibre for moisture is

* A. S. T. M. Tentative Method of Test for Fibre Length of Wool, D 519–38T.

** Tests made at Lowell Textile Institute and tests made in Forstmann Woolen Co. laboratory gave similar results. At 65% R.H., 70° F., the moisture content when approached from the dry state was found to be 13% against 15% when approached from the wet state.

reduced. There is no doubt that the drying research project will result in solving some of the wool problems connected with moisture.

Shrinkage

One of the most difficult tasks the wool industry has to deal with is the accurate judging of the shrinkage of raw wool. Burns defined shrinkage as follows:

> "The fleece of the sheep contains varying amounts of extraneous material, such as dirt, sand, burrs, seeds, greasewood, cactus, and paint; and indigenous material, such as sweat, excreta, and grease.
>
> "The commercial value of a fleece or a clip of wool is, to a large extent, controlled by the amount of clean fibre that it yields. The weight of clean wool fibre, as expressed by the percentage it makes up of the original weight of greasy wool, is spoken of as the 'yield.' When an allowance is made for the impurities remaining in the scoured wool after it is washed the term 'clean content' is used to describe the clean wool which contains no impurities. The percentage of the original weight of the greasy wool removed by scouring is spoken of as the 'shrinkage.' The commercial shrinkage is based on the billed weight of grease wool. The commercial value of a clip or lot of wool cannot be ascertained until the shrinkage and grade are known or estimated by competent wool handlers."

Government agencies, such as the Treasury Department for customs purposes, and the Department of Agriculture for breeding purposes, have to test the shrinkage of small samples of wool. In the first instance the determination is used as a basis to establish the amount of duty to be paid on imported wools. In the second instance it is used to inform the breeder how to evaluate his product.

All previous attempts made to get comparative results with the entire lot when processed at the mills have failed because of unsatisfactory methods of sampling. In the last two years considerable research was made to develop a standard method for sampling bales of wool by the two government agencies mentioned in collaboration with some mills and the Wool Section of the A. S. T. M. The results obtained up to now are very promising.

Dr. Wollner of the U. S. Treasury Department was able to report, at the March, 1939, A. S. T. M. meeting, the result of a sampling test made on skirted Australian wools. In his summary he made the following statements:

> "By the application of the principles of statistical method it is possible to obtain samples from lots of skirted Australian wool which are truly representative of the hard scoured yield, and which have pronounced advantages. The frequency distribution of the hard scoured yield in bales of skirted Australian wool is approximately Normal. The standard deviation, for portions of uniform

weight of between 50 and 200 grams, is about 5.0 when such portions are drawn at random by hand and consist of contiguous greasy wool.

"A sample composed of 270 or more portions, each approximating 60 grams in weight, taken purely *at random* from a group of bales having about the same estimated yield, will represent the average hard scoured yield of the bales to within 0.5% with a probability of 0.90. The chance of the error exceeding 1.0% is about 1 in 1000.

"When a large lot contains bales having different estimated yields, each percentage group may be separately sampled as above. Under certain conditions (the bale frequency distribution is approximately Normal) the entire lot may be sampled as a unit by taking 270 portions at random. Triplicate samples of 310 portions each, taken from a lot of 310 bales of skirted Australian wool, had hard scoured yields of 65.3%, 65.6%, and 66.0%. The average for the lot was 65.6%. The maximum theoretical error calculated for these samples was $\pm$ 0.5%; the actual maximum error was 0.4%."

Tests made by Dr. Burns in the Department of Agriculture, and reported at the October, 1939, A. S. T. M. meeting, showed on the basis of three domestic lots that the yield of samples collected differed less than 2% from the actual mill yield, which as far as the practical information to the wool growers is concerned is acceptable. A test at present in progress on 300 bales of Montana wool by the Wool Section of the Department of Agriculture and the Forstmann Woolen Co., is very promising.

Tentative results on 60% of the lot are as follows:

	270 Bales 76,000 lb.	30 Bales 7,400 lb.		Samples taken from 30 bales		
				90 Fleeces	Random Sample	
					A	B
Yield	58% 43.69%	54% 43.74%	40% 44.91%	780 lb. 43.80%	240 lb. 44.61%	30 lb. 43.86%

The scouring method used for the laboratory samples is the proposed laboratory method of test for shrinkage of grease wool as just published in the new October (1939) issue of the A. S. T. M. Standards on Textile Materials. These tests prove that the result obtained by the Treasury Department on Australian wool can be just as well obtained on domestic wool when the samples are properly selected. From these results the day does not seem to be far distant when this old problem may be licked just as the problem of fineness has been solved.

It has been my endeavor to bring out the progress made in establishing scientific ways and means of determining the main properties of wool, such

as fineness, length and shrinkage, which are the controlling factors for the commercial value of this commodity.

The fineness and length problem may be considered as solved satisfactorily for its adoption by the wool industry. The shrinkage question is on the road to being solved in the near future.

It is hoped that the moisture problem for wool may be tackled as part of the textile drying research project. The necessity of developing a standard conditioning oven is most apparent. The question could be raised also of the possibility to establishing conditioning houses similar to the European method for arbitration purposes.

It is one of the laws of nature that the deeper you dig into a problem, the more you realize how very little you know. And also that the solution of one problem will always mean the birth of several new ones. Therefore, there is no limit to the problems left. Among them, to mention a few, are: The establishment of the fundamental microscopical structure of the wool fibre; the ascertaining of data on strength and elongation of American grown wools and the relationship between each grade. These studies could then be used as the basis for further mill research on the influences of the various manufacturing processes in regard to strength and elasticity.

Gentlemen, in leaving these thoughts with you, I sincerely hope that our work may not be interrupted by war, as such problems can only be thoroughly taken care of in times of peace.

From the Point of View of the Wool Manufacturer

By RINALDO A. LUKENS *

THE research project on the drying of textile fibres, conducted for the past two years by the U. S. Institute for Textile Research, Inc., with the co-operation of a small group of manufacturers of textiles and textile machinery, has had as its objective the ascertainment of some of the fundamental facts underlying the design of drying equipment for textiles, the development of information about the way textiles can be dried with maximum efficiency and minimum injury to the materials, and to assist in applying this information in individual plants.

After a preliminary survey of the available literature on textile drying, it was found necessary to design and build the equipment required for the determination of the effect, on various textile fibres, of elevated temperatures, coupled with controlled relative humidities, in drying.

As might be expected, a marked difference has been observed in the effect upon the tensile strength, elongation at break, and the capacity for moisture regain of the various materials tested, under comparable conditions of drying.

For the purpose of this discussion, only the wool fibre will be considered, in relation to the degree of degradation determined by these drying tests at controlled temperatures and humidities, and the generally acknowledged hazards of impairment of the natural properties of wool and other animal fibres in such processes as scouring, dyeing, yarn manufacture, fulling, cloth finishing, steaming, sponging and pressing.

* Vice-President, Continental Mills, Inc., Philadelphia, Pa.

It has been contended that the least harmful method of drying wool is with air alone, but such a procedure would require too long a time, and entail the use of too much space, to be practical under modern manufacturing conditions. Consequently, continuous types of drying machinery have been developed, embodying the principle of combining heat and air circulation in the most effective manner, with what has at times been regarded as undue emphasis on productive capacity at the expense of fibre quality.

Surprisingly, however, the tests completed on the drying of carpet and clothing wools show that the effect of heat is less than that of humidity, as measured by the "quality index," which is the percentage of the original breaking strength multiplied by the percentage of the original elongation. This is particularly true of the coarser carpet wool, which shows the greater deterioration at a high humidity, and is less resistant to heat and humidity than the finer clothing wool.

It is difficult to reconcile such a finding with generally held concepts of the effect of high temperatures on various types of wool in drying, especially when it is noted that the test results show further that, when exposed for periods up to one hour, which is ample time for most raw stock, yarn or cloth drying treatments, there is little if any depreciation in the quality index on either carpet or clothing wools at temperatures of 221°, 257°, and 302° F., except in the higher humidity ranges on the carpet wool.

The determination of moisture regain on the clothing wools, after exposure to these high drying temperatures, also fails to show any particular impairment of the fibre in this respect.

However, before these findings can be accepted as clearing up a fundamental misconception of the factors which bring about fibre deterioration in wool drying, it must be remembered that the experiments were carried out on clean, purified fibres, freed from the presence of alkali, acids, salts, sizing or finishing materials, and with little or no injury from prior commercial types of processing. Recognizing the probability that the introduction of these elements into the situation may materially affect the reaction of the fibre to any given set of drying conditions, it was planned to make further tests on wool types which more closely approximate the conditions encountered in normal manufacture, and it would be advisable to withhold acceptance of the principles indicated by the results thus far obtained, until these check tests have been completed, and carefully appraised.

It should be apparent that the successful working out of formulae for the most efficient wool drying practices, while a highly important contribution to the advancement of textile manufacturing technique, will not of itself solve the major portion of the general problem of fibre deterioration in processing. Attention must also be given to the need for study, along similar lines, of those other processes previously mentioned as playing a vital part in the cumulative effect of treatments which tend to degrade the fibre. Those exposing the fibre to the actions of alkali, acids, dyestuffs, mordants, chemicals, soaps and oils, in combination with water and heat, should be given first attention, as all of these are closely allied with, and precede the drying of raw stock, yarns and cloth.

There is a fertile field for study here, and one in which the average textile mill is in need of reliable, disinterested information, as an aid to maintaining quality in its product. Management, under pressure of competitive conditions, has progressed rapidly in the direction of improved mechanical facilities and personnel efficiency, but has been slow to recognize

the imperative need for intensive research in the field of the chemical and physical properties of the raw material, to keep pace with the advancement made in production methods.

Many commonly accepted practices in the treatment of raw stocks, and materials in process of manufacture, would not stand the test of close and analytical examination, uninfluenced by tradition or conclusions based upon so-called practical observation. A case in point is the general custom of overscouring wools which are prepared by dealers for sale to mills which do not have their own wool scouring equipment. This procedure, coupled in many instances with a bleaching of the fibre, is designed to enhance the attractiveness of appearance of the wools, but certainly does not add to their subsequent working properties, and on the contrary may result in definite degradation of the fibre through the use of the amount of alkali and severity of treatment required to reach the degree of cleanliness deemed essential for sales purposes. Wools scoured mildly, with a minimum of alkali, and with a reasonable amount of nature left in the fibre, may not look so attractive, but are likely to exhibit less damage, and be in better condition to withstand the rigors of dyeing and other subsequent manufacturing processes.

There is still much to be determined about the effect on the wool fibre of different methods of dyeing, and its reaction to various bath temperatures and time of exposure in the presence of the acids and mordants commonly used. Some investigators along this line have claimed that wool boiled in plain water loses more strength than when boiled with the chemicals used in the ordinary dye bath, and that there is a continuing and progressive loss of strength, the greatest loss taking place in the first hour of treatment. On the other hand, in solutions of acetic acid, sulphuric acid and chromium salts, there is also a loss of strength during the first hour, which is not increased materially by further boiling. It was also claimed that with acetic acid alone, which is very mild, there was a greater degree of progressive loss in strength than with stronger chemicals.

The determination of the best types of spinning emulsion to meet the need for adequate lubrication of the fibre, and subsequent ease of removal in yarn or cloth scouring, also offers many interesting angles, and the scouring of yarns and cloth has many problems in common with those of wool scouring, as well as others peculiar to handling wool in the form of yarn or cloth.

Fulling is another process that is still being performed in accordance with the principles used in the infancy of textile fabrication, the main change being in the substitution of high speed mechanical units in place of pounding by hand. The felting action of the wool fibre is induced by a combination of lubrication, frictional heat and pressure, in a manner none too gentle, and the resulting shrinkage reaction is not definitely predictable nor subject to positive control. The possibility of applying new knowledge of the chemical and physical properties of wool to the development of a new and less severe method of accomplishing controlled shrinkage, offers an interesting subject for speculation.

It would be possible to continue along this line far beyond the limits of your patience, but it is obvious that the wool fibre, in its conversion from the natural greasy state to a finished fabric, is subjected to terrific punishment, a great deal of which may be found unnecessary and avoidable, if examined in the light of its known chemical and physical properties.

An effectively planned, and liberally supported, program for the collection of pertinent data from all available sources, plus a "proving ground" for the working out of practical application of the best of these research findings to manufacturing procedures, would be of inestimable value.

This is the sort of thing that few concerns in the woolen business could hope to accomplish individually, but it should be possible for the Institute to organize such a service to those in the industry who believe that advancement in technical developments must be kept in step with the forward strides being made in synthetics, if woolens are to hold a position of public acceptance and favor.

Outline Report of Discussion

FOLLOWING his formal paper and prior to the opening of general discussion, Mr. Lukens spoke extemporaneously as follows:

"I notice in looking at the program that the subject 'Wool Processing in the Light of New Knowledge of the Chemical and Physical Properties of Wool' has been assigned to this session. We have heard a lot today about some of the known properties of wool, but there has been little said about just what we can do about it. We will carry this information away with us and we may or may not do something about it.

"The subject which I am here to throw into the ring is: What can be done about it, and what can the Institute set up in the way of a method of accomplishing a service to the industry?

"Those of you who heard some of the earlier reports today know that one of the difficulties has been lack of the proper amount of financial support from the industry on the various phases of research that the Institute has been endeavoring to carry out. It is surprising that should be so, but, nevertheless, it is a fact.

"I don't have in mind, in the suggestion that I made two years ago and which I was asked to follow up today, anything in the way of an elaborate laboratory set-up; but I do feel that the average manufacturer, who perhaps should know where to get this information, does not know where to get it. He reads a great many articles in the various trade and technical publications which bear upon some one phase of the subject and, in some instances, he finds something there that he can put to work. But even articles written by the best of authorities may be radically changed later by additional work on the part of the same research workers.

"It would be a fine thing for the wool industry, because of its peculiar makeup, if in the Institute we had a method of gathering together the published results, or results that could be determined by direct contact with the research men, and if before releasing those results with any recommendation to the industry a certain amount of check-up could be made in the Institute from a laboratory standpoint; then those who are interested in this subject might be glad to place their plants at the disposal of the Institute for a practical check-up. A field man could come in and demonstrate whether there is a practical application for the theory which has been checked in the Institute.

"Further, in rendering reports for manufacturers generally, I would suggest that, in addition to the highly technical treatment which is necessary in order to cover the subject of the particular research, a summary in plain,

everyday language understandable to the ordinary textile manufacturer be gotten up and included. I think that is vitally necessary. I find considerable difficulty, not being a trained chemist, in getting very much out of some of these very excellent reports that I read. I think I would be helped tremendously if someone who knew how to interpret them into language which I could understand, and might make some use of, would tackle that job for the Institute and let me have it in that form so I could go to work with the information.

"I hope I have been successful in conveying the idea. It is going to mean additional support beyond the projects now under way, but certainly there should be in the wool industry enough manufacturers with sufficient vision to be willing to spend the money necessary to prevent this very excellent research work from going to waste, or being confined in its presentment to discussions among the research workers and technical men."

Study of Cause of Defects Recommended

In throwing the meeting open for discussion the presiding officer, W. D. Appel, Chairman of the Institute's Research Council, stated that those participating would not be stenographically reported by name unless they were willing to have their names used, and that it was hoped that this would encourage frank expression of opinions and recommendations.

Mr. C.: "I would like to make an appeal for a little different line of work than has been mentioned thus far. We all recognize the importance of fundamental research, but there is something else besides fundamental research the industry is interested in, and I think that if the aim of the Textile Foundation is to give the industry the maximum help that it can for the money that it has to spend, there is one line that has been neglected.

"The previous speakers told about the things that influence wool: the drying, the heat, the humidity, and, of course, we all know about bacteria, acids, and alkalis. The manufacturer knows that all these things have an influence, but a good many times when defects come into textiles it is quite difficult to locate the source of the defects. It is really the most important part, because once you know the cause of the defect the removal of the cause is usually quite easy.

"The amount of damage that is done to wool through the stress of production is enormous, and I appeal to the Foundation, either through the agency that we have had, or, if that has fallen down and cannot produce the desired results, to have the work done at the National Bureau of Standards, on a program along the lines of helping to diagnose faults when they occur.

"We have wool that is damaged in various ways: it may lose strength, it may not dye properly, it is streaky and cloudy, and all sorts of things, and we do not know whether it was caused by bacteria, heat, acids, alkalis, or what-have-you. It is a difficult subject and a good deal of work has been done on it, but I am convinced that the Foundation couldn't spend its money to better advantage than by supporting a program that would help to diagnose defects after they have occurred."

Chm. Appel: "The Research Council has been very proud of the fact that it has had support in some of its projects from the Textile Foundation. We have been ever prouder of the fact that we have been able to go out and start some of these co-operative programs financed solely by the industry. Mr. Lukens, do you think that the ideas mentioned by Mr. C. would fit into the program?"

Mr. Lukens: "There might be some difficulty. I am not certain whether Mr. C. is talking about the investigation of the causes after defects occur. I assume that he is. I was speaking primarily of insurance against those things happening. I feel that if the manufacturer had available more definite information concerning the safe working ranges in respect to heat, moisture, temperature, actions of alkalis and acids, etc., and if he knew very definitely what could be expected in the way of a reaction under certain conditions, he could then, as a simple matter of manufacturing control, go a long way toward avoiding those happenings.

"I believe that the type of work Mr. C. mentioned—investigating the cause of happenings—is something that is very essential, and we are all faced with that problem. . . . I would say that it differs somewhat from the thing I was talking about. I am rather carried away with the idea that the raw material is the most expensive thing we have to handle. It probably represents 50% or more of the cost of finished merchandise. We don't pay enough attention to how much we are impoverishing the working properties of the wool. We don't have enough reliable information on the subject.

"I haven't the figures, but if you would just conceive of the value of the wool used in manufacturing in one year's time, and know that perhaps 10% of the value could be saved through a more intelligent conception of how to avoid damage to the fibre, you can realize how much the value of the finished fabrics would be enhanced, and what it would mean to the industry in a very short period."

Drying Project May Aid This Study

Dr. Walker:* "I feel impelled to amplify something that Mr. Lukens said in connection with what I can visualize we could do during the coming year with just a little bit more financial assistance. Most of you here are interested in wool. That is why you are here this afternoon. Wool has been a part of our program of drying research at the National Bureau of Standards. If we could have enough additional funds to provide an assistant for this year, we could take a piece of equipment that we have for getting equilibrium moisture and heat conditions in our textiles, and take wool which had been processed in a variety of ways and in a very short time we could get information regarding the effect of chemical treatment, various types of alkali and acid treatment and the effect of impurities of various kinds on wool, and tell you, as we have tried to tell to a limited extent this year, what would be the effect in drying of those materials upon the tensile strength and certain other properties.

"It seems to me that for an additional amount of investigative effort we should be able to provide the information, because we have the equipment and the background. We are planning to close this job up this year. Unless we get some of the valuable information mentioned, it won't be done for some length of time. But here we have right in our hands the chance to give you a lot of valuable information on wool."

Bacteria in Damaged Wool

Mr. B.: "What I am primarily interested in now is this termite that Dr. Harris mentioned that likes to browse around in wool scale. Has he progressed far enough in his research to tell us whether the bacteria enter

* Chairman, Administrative Committee for the Institute's textile drying research.

the hair where it is cut, or does it attack at the surface, or from the inside and eat out? I think that would be of great interest.''

Dr. Harris: ''In all of our experiments, it appears that the bacteria enter the fibres at the point where you damage the scales or perhaps the layer right under it.''

The Basic Approach to Damage Evaluation

After answering Mr. B., Dr. Harris continued as follows: ''I would like to add one thing here if I may: We have several visitors a week, and two out of three of them ask, 'How can I determine wool damage?' That word, 'damage,' is a really difficult one to evaluate because it is used to include everything. Someone works out a test for a specific type of damage for wool, and everyone starts using it for everything else. Wool is subjected to many processes and, in order to evaluate the effect of each process, we would have to understand the fundamental changes produced by one of the processes. A test for measuring alkali damage might be a very different test from that needed to measure carbonizing damage or physical structural damage. A number of false conclusions have been reached because the minute a new test came out, everyone applied it to everything.

''As a result of a study of the fundamental changes in wool which were produced during oxidation, we were able to devise a simple method—the alkali-solubility test—for estimating the extent of oxidation. Now, however, we find that that test is being used for everything and some people complain that it doesn't work. This is a serious problem. If you are going to evaluate damage you must, as pointed out by Mr. Lukens, understand the mechanisms of the reactions producing damage. This is also necessary before you can satisfactorily prevent damage.''

Mr. A.: ''There is one point on which I would like to ask Dr. Harris a question: Are the forces between the cells which you and Mr. Von Bergen linked together in corkscrew effect of some kind measured by the pull on the strand? Is the injury to the linkages measured by longitudinal stresses only?''

Dr. Harris: ''We do not know at this time the nature of the forces holding the cells together. It appears, however, that the forces between the cells are apparently greater than those inside the cell. The reason I say that is because after stretching a fibre as much as 100%, the fibre under suitable conditions return to its original length, indicating that the cells aren't slipping over each other since there would be nothing to bring them back into position. We have been able to demonstrate that the complete elongation of the fibres is represented by the elongation of these cells.

''Strength measurements in themselves are poor criteria of the effects of various materials or reagents on the wool fibre. It is actually possible to damage a wool material considerably and obtain an apparent increase in tensile strength. The real value of wool as a fibre lies in its long range extensibility and elasticity, determined by stress-strain measurements of single fibres.''

Scope of Research Program

Chm. Appel: ''Scouring is one of the various stages of processing and we have a lot of scientific information on the effect of scouring agents on the wool fibre. Is it your idea, Mr. Lukens, that someone will consider, say, scouring from the broad point of view as it is conducted in the industry

with reference to these scientific data, and attempt to point out wherein the research studies have a bearing, so that a mill can then go to work on its particular problems, or do you propose carrying it further and, first finding out how much of an objectionable effect there is, by and large, in scouring, decide whether scouring is one of the things that should be taken up or not, and then proceed to other processes?''

Mr. Lukens: ''The first step in this research should be to determine how much reliable fundamental information we have affecting the reaction of wool fibre under certain conditions, whether they be exposure to alkalies, to acids, to heat, to moisture, or whatever it might be.

''Having determined that and established the necessary tolerances, we could then move, we will say for example, into the field of wool scouring and see whether wool scouring brings into the picture any factors which are not covered by the fundamental information which we have assembled.

''If we find that there is some factor there which we have not taken into consideration, we can then endeavor to determine how that can best be controlled. That doesn't mean that someone has to go into the wool scouring plant and study wool scouring. I am talking now in terms of fundamentals—not about improving the process of wool scouring, or of drying or fulling, as the case may be. I think that Dr. Harris, or anyone doing that type of research work, has a pretty good knowledge as to just what conditions have to be met in those manufacturing operations. If not, they can easily find out.

''That would be my recommendation on the way to start: First, assemble the information we have and make that information available to those in the industry who can put it to work.

''Today, we are compelled to get our information from many different places. As I think I said before, we read technical publications on one subject or another, and we often wind up by doing very little.

''As Dr. Harris said in connection with the test he mentioned, we might go overboard in putting into practice the whole operation because we haven't considered some of the other things in the equation.

''I think the thing could be done with a rather moderate step-up in the present activity of the Institute, such as suggested by Dr. Walker. The important thing is to get this information together and analyze it from the standpoint of the additional information that is needed by manufacturers about the ranges of tolerance to certain conditions. They know how to manufacture; they know something about the conditions that occur in their processes; with the additional needed information they can use their intelligence to keep within the ranges of tolerance on the several factors that enter into any operation.

''I wouldn't dare suggest that we go into a study of every process with the idea of improving it. I would come around here with long whiskers looking for the results when we got through.

''We must not forget that if we are able by a research of this kind to reduce fibre damage materially, we will not only increase the quality of our products, but will automatically bring about a reduction in our manufacturing costs. We have all experienced the difficulty of trying to do the job with damaged fibre. It takes more time, involves stoppage of units, and in many ways adds to our supervisory problems and our manufacturing costs. Certainly, we need to be in a position to reduce manufacturing costs from every angle, for if this war blows over we will be back in the position

where we must face a determined amount of effort from the other side to capture this American market. Let's not be lulled to a false sense of security by the fact that that pressure has let up a little bit, for, sooner or later, we are going to be right back with our foot in the bucket on that proposition.

"I would suggest, if you want to bring the thing to a head, that we recommend to the Institute, through its proper Committee and officers, that ways and means be determined, the practicality of the plan be settled upon, and if it seems a practical approach toward rendering a service to the industry along the lines that I have been trying to talk about here today, perhaps none too clearly, then the ways and means for financing the project be looked into."

Favors Starting in Drying Project

Dr. Smith: "I would like to say that it seems to me that Dr. Walker's suggestion is a very practical way of getting started. They have, after all, a set-up which will enable them to do one of the very important phases you are talking about. Without the setting up of another research committee, if there were 10 woolen people ready to jump into contributing memberships, you could immediately have an assistant who, while he would be doing drying research, would be giving you a lot of the information that you want on what takes place in these fibres which have been treated in various ways chemically and physically and then subjected to drying. You would then have something on which to hang your program and then in the course of a year you could develop a more comprehensive program. It would have the advantage, also, of terminating this drying research. I think that would be a very practical way to start."

Chm. Appel: "Dr. Walker, I want to ask whether you would contemplate with this additional assistance limiting your work to the drying angle of it, or whether it could or would be extended to some of these other phases that are not directly drying problems—that is, the collation of the data in the literature on wool which might apply to wool processing?"

Dr. Walker: "As a matter of fact, Mr. Wiegerink has collected considerable textile information on drying which he has used as a background. At one time he planned to get it together and make up a final report and send it around to the various contributors, but the difficulty with that was that such a compilation would not be critically analyzed by us. We simply didn't have the time to devote to that particular thing. I know that Dr. Harris made an analysis, or a report on abstracts of wool papers.

"One more step in Mr. Lukens' direction would be to have all that information taken and intelligently correlated by not one but by two persons. Take a research scientist for one and a practical man such as a mill executive for the other, and have the two of them get together and look over the literature and say: 'This bit of experimental evidence is all right, but it doesn't check up with something else.' What we need is a correlation of that sort, from the standpoint of the practical implications of all this research literature that we have.

"Take a man who is going to do a job on one phase of drying research, if he could be permitted to take some time to put that together and discuss it with, say, our committee which represents several different aspects of the industry, I should think we would be able to get out for you an intelligent summarized product of literature, together with the experimental results of

our tests on drying of wool which has been processed in different ways. It would be something which would be extremely valuable."

Constructive Advice Requested

Chm. Appel: "Probably a good many feel as I do, that you would like to think about this. When you get home you may have some very brilliant ideas on further thought. We would like to have you send those to the Research Council or to Mr. Clark, the Secretary, for consideration by any small committee we may appoint to look over the record and to consider ways and means for what should be done.

"I urge you not to stop thinking about the problem here, but to give us your advice on later developed ideas. I can assure you that your opinions expressed here will receive the careful consideration of the Research Council, and I want to express our appreciation of your coming here and for your interest shown in the problem."

Stenographic Report of Discussion

AS ANNOUNCED prior to the open conference on Fibre Damage in Wool Processing, advance orders for a stenographic report of the papers and discussion were accepted at $2.00 per copy.

Additional copies can be furnished at the same price until the supply is exhausted.

Correction

PLEASE note the following correction in the article by Winn and Schwarz in the November issue (pp. 5–16) entitled "Flexibility and Drape as Measurable Properties of Fabrics": In the second and third equations on page 11 the sign preceding the "c^2" term should be plus (+) instead of minus (—).

Refractive Indices of Textile Fibres: Double Variation Method for the Determination of

By KENNETH R. FOX, B.T.E.*

A Textile Foundation Publication

It has long been the opinion of many textile technologists that some precise and easily duplicated means of determining the index of refraction would be of paramount value in investigating the structure of textile fibres as well as assisting in their positive identification. Such other phenomena as the effect of moisture content, the effect of strain or the so-called "memory" of plastics (such as silk, wool, rayons, etc.), the identification of faulty yarn due to excessive tension or other orientation of structure,† the effect of mercerization, the correlation of index values with the quality of wool or the grade of cotton—all offer fields of study in fibre research provided that a precise means of refractive index determination is possible. It was with these problems in mind that the present work was begun on a more precise and convenient method of measuring the refractive indices of individual textile fibres.

Method and Apparatus

"THE INDEX of a transparent material changes with wave-length of the light used for illumination of the material and with temperature of the substance. The wave-length change will be designated as the chromatic dispersion of the material, and the temperature change as the thermal dispersion. While these properties are characteristic of all substances, it will be found that, generally speaking, the dispersion for fluids is much greater than for solids. With this characteristic as a basis, the following set of conditions may be arranged: Let it be supposed that there is a fibre immersed in a liquid, the refractive index of which is near that of the fibre. Since the indices of the fibre and of the immersion

* Graduate student, Textile Laboratory, Massachusetts Institute of Technology. Research conducted under the direction of Prof. Edward R. Schwarz.

† Recent tests were conducted on two viscose samples one of which produced dark streaks in a sample of cloth. The indices of fibres taken from the dark streak were found to be 1.5285 and 1.5146 giving a specific index of 0.0139, while the fibres from the light portion gave 1.5391 and 1.5150 with a specific index of 0.0241. It is interesting to note that the index of 1.5391 is rather closely that which is found in ordinary practice for the usual type of viscose filament, while 1.5285 indicates unusual conditions. It is expected that the lower indices would be essentially the same as they are to the third significant figure. It is reasonable to conclude that either the latter filaments are essentially different from the former in source, or that they have been excessively strained.

liquid change at different rates with a change in wave-length, it will be possible within certain limits, by varying the wave-length of the illumination, to find some wave-length at which the fibre will exactly match the liquid in index. The range over which this adjustment will be possible depends on the change of dispersion of the liquid relative to that of the solid.

"Moreover, the refractive index of a liquid varies rapidly with a change in temperature. This change, called the thermal dispersion, is high for liquids and low for solids. In the case of the latter it is usually confined to the fifth or sixth decimal place. Change in the temperature of the immersion fluid affords, then, a second means of varying the index of the liquid to match that of the fibre."[8]

Now, if a fibre is immersed in a fluid of quite different index of refraction from the fibre, it can be easily discerned through the microscope. If, however, the indices of the fibre and fluid are the same, the fibre will move to extinction (disappear) indicating a perfect match between fibre and fluid indices. The relative position of the fluid index to the fibre index can be obtained by means of the Becke line, the details of which can be found in text-books by Chamot and Mason,[1] Johannsen,[2] or Preston.[3] The fundamental problem is, therefore, to obtain a fluid of the correct index by means of temperature and wave-length variations and then determine its value under the same conditions as when viewed through the microscope.

The assembly of the apparatus used is indicated in the photograph. The design and partial assembly of the equipment was done by Mr. M. A. Sieminski, formerly a research assistant in the Textile Laboratory of the Massachusetts Institute of Technology (working under a grant from the Textile Foundation).

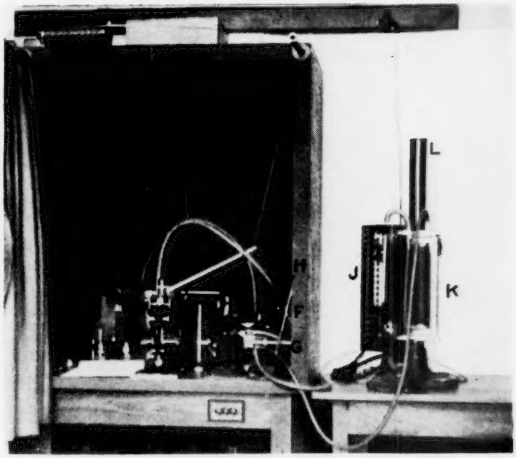
The source of illumination is an arc lamp with a clock feed. The clock feed mechanism avoids the necessity of constant readjustment of the carbons as they burn. It has been found in actual practice that the mechanism is not fully automatic, requiring some adjustment in use, but the mechanism works well enough so as not to require constant attention. This light then passes through a heat absorbing water cell to the monochromator. This piece of apparatus consists of a wave-length spectrometer used in conjunction with a shutter eyepiece to control the spectral purity of the lines selected. The direct-reading wave-length drum is an essential feature of this instrument since any desired wave-length of light can be obtained rather quickly and easily. Light may then be passed either to the refractometer or through a bulls-eye condenser to the microscope.

The refractometer is of the Abbé type equipped with water-jacketed prisms but without the customary Amici compensating prisms. The omission of these prisms was considered desirable in view of the fact that a slight deviation from parallelism of the prisms leads to a small error in the index readings obtained. The refractometer used is calibrated for sodium light so that it was found necessary to correct the refractometer readings for the monochromatic light used. Such a correction curve is furnished with the instrument and was employed in the data recorded with this equipment.

The microscope is equipped with built-in polarizer and graduated rotating stage. No analyzer is employed. With this microscope is used a special constant temperature stage plate through which water is circulated to maintain the immersion fluid and specimen at any known temperature.

The temperature of the circulating water is controlled by a special heater and control unit to give a steady flow at a specified temperature.

To facilitate the reading of the index scale on the refractometer, a lamp housing has been designed and constructed to fit on the quadrant of the refractometer. Thus, the bulb illuminating the index scale will remain in a fixed position relative to the eye-lens regardless of the position of the movable arm. An illuminating scale reading device has also been constructed so that the wave-length drum of the monochromator can be read from the observer's position at the microscope. This is requisite since the



THE APPARATUS

(A) Automatic arc light and cooling cell. (B) Polarizing microscope with temperature controlled stage. (C) Thermometer (temperature of water leaving stage). (D) Monochromator (spectroscope). (E) Refractometer (temperature controlled prisms). (F) Thermometer (temperature of water entering refractometer). (G) Thermometer (refractometer prism temperature). (H) Periscopic illuminating and scale viewing device. (J) Temperature regulating rheostat (circulating water heater). (K) Auxiliary rheostat. (L) Constant head water supply tower. (M) Suspension to allow 90° rotation of temperature controlled stage.

angle of inclination of the monochromator when in use is such as to make it difficult for one to see the drum accurately without some such scale illuminating and reading attachment. This attachment consists of a lens and a mirror combination on the order of a small periscope.

Because the refractive index measurements are made at fairly low intensities of illumination, it was found best to conduct such tests inside a special wooden housing to inclose the apparatus and the observer. The housing is painted a flat black within and is covered on one side by a curtain. A dome light within the housing serves for general illumination for the purposes of noting data.

A set of standard immersion fluids used with this equipment were made up by Lappé [4] as a part of a thesis conducted at M. I. T. during 1934. His set includes thirty-one bottles of different concentrations of alpha-monochlornaphthalene and 300° F. boiling point kerosene distillate.

This series of fluids has many desirable features as suggested by Butler: [5]

(a) Adjacent liquids have closely identical optical properties other than index. Therefore, all properties are closely a linear function of composition, with the increment other than index a minimum.
(b) Any two liquids are miscible and the index of any intermediate member is a straight line function of its composition.
(c) The liquids are permanent, *i.e.*, retain constant properties under all laboratory conditions.
(d) Solid matter does not settle out on standing.
(e) The mixtures are clear, colorless, non-poisonous, and free from objectionable odors.
(f) The liquids do not react chemically with each other nor with the substances tested.

Prof. E. R. Schwarz [6] corroborates the advantage of having fluids whose index is a simple function of composition, so that

$$n = \frac{n_1 v_1 + n_2 v_2}{v_1 + v_2}$$

where n = index
v = volume.

Such a relationship presents a simple means of fluid mixing in order to approximate a desired index of the mixture.

The following table lists the indices of the standard solutions at the wave-lengths noted.

Temperature Control

The essence of this double variation method of index determinations is control. In order, then, to find out just what degree of control could be obtained, the constant-temperature control equipment was first calibrated. Fig. 1 shows the temperature increase, *i.e.*, the temperature differential between the tap water and the circulating water temperatures versus heater scale readings. These values were used to obviate any tap water temperature fluctuations. The equipment has two heaters separately connected so that one may be run independently of the other. The first set of readings was taken with the main heater on and a flow of 1000 cc. per minute. When the full scale of this heater was reached, the auxiliary heater was set at its zero position and plugged into the line. The initial effect of this heater is an increment of 3.5° C. as shown by the curve. The remaining temperatures represent the heating effect when the auxiliary heater settings were varied. This same procedure was followed with a flow of 500 cc. per minute. It was found that an interval of about ten minutes should be allowed between heater settings to allow for temperature equilibrium to be reached. During test runs for duplication of temperatures it was observed

REFRACTIVE INDICES OF STANDARDS

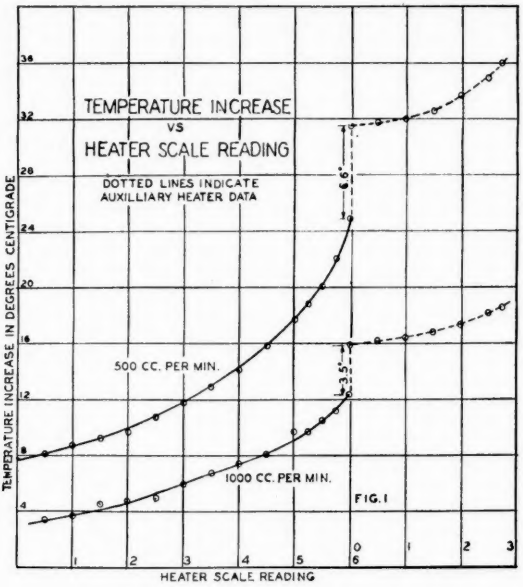
Bottle	$(n)^D$ 20° C.	(n) 480 mu. 27° C.	(n) 680 mu. 27° C.
1	1.4509	1.4528	1.4465
2	1.4559	1.4616	1.4500
3	1.4612	1.4668	1.4545
4	1.4664	1.4727	1.4598
5	1.4716	1.4785	1.4647
6	1.4766	1.4830	1.4703
7	1.4812	1.4881	1.4737
8	1.4861	1.4940	1.4790
9	1.4922	1.5010	1.4848
10	1.4971	1.5063	1.4899
11	1.5020	1.5118	1.4945
12	1.5072	1.5178	1.4999
13	1.5122	1.5227	1.5045
14	1.5179	1.5291	1.5098
15	1.5228	1.5340	1.5146
16	1.5280	1.5398	1.5189
17	1.5327	1.5457	1.5244
18	1.5378	1.5510	1.5290
19	1.5431	1.5568	1.5344
20	1.5476	1.5618	1.5386
21	1.5528	1.5677	1.5441
22	1.5581	1.5741	1.5488
23	1.5628	1.5789	1.5535
24	1.5681	1.5841	1.5582
25	1.5730	1.5893	1.5628
26	1.5773	1.5940	1.5668
27	1.5831	1.6004	1.5723
28	1.5874	1.6051	1.5767
29	1.5928	1.6108	1.5815
30	1.5978	1.6162	1.5866
31	1.6026	1.6214	1.5912

n of kerosene oil = 1.4500^D 20.0° C.
n of alphamonochlornaphthalene = 1.6317^D 20.0° C.

that, with a moderate amount of care, temperatures could be chosen at random and duplicated within 0.5 of a degree. It was also found that the curves could be graphically scaled at any point to give temperature readings covering the range between the highest point of temperature increment due to the main heater and the point where the auxiliary heater was employed.

Now that the temperature of the circulating water could be controlled, the next step was to determine the effect of the different temperatures on the immersion fluid indices. Fig. 2 shows the effect of temperature on the uncorrected indices of four separate bottles when viewed by light of 540 mu. wave-length. Fig. 3 indicates the displacement of the previous curves when corrected for the wave-length of light used. As the same light was employed for each fluid, the same correction value was used for each refractometer reading. It can be quite safely concluded that the relation is linear and that the coefficient is the same for all bottles. The intrinsic uncertainty of the refractometer is $\pm$ .0002, and as the index varies 0.0005 with one degree Centigrade it is then possible to have as large a divergence as 0.4° C. between the refractometer and microscope stage without exceed-

ing instrument errors. Cognizant of this fact, thermometers reading tenths were installed in the circulating water just before the refractometer and just after the constant temperature stage attachment on the microscope. If these two thermometers differed by less than 0.4° C., it was then possible to proceed with any determinations desired. From test runs it was found that as low a temperature differential as 0.2° C. could be obtained, depending upon the time allowed for equilibrium to be reached in tubing and instruments, the temperature of the room, and the circulation of air over the apparatus. The time to allow for stable conditions depends entirely on the increment of temperature employed, but for changes of five to ten



degrees an interval of about ten minutes should prove sufficient under ordinary conditions.

Effect of Wave-Length on Fluid Index

The next phenomenon investigated was the effect of wave-length of light upon the refractive index of the different fluids with the temperature held constant. The results obtained from the tests are shown in Figs. 4 to 9 inclusive. Fig. 4 shows the values from the fluids in four of the bottles as noted, each at two different temperatures. It is noted that the curves tend to change from concave downward to concave upward as the uncorrected indices of the fluids advance. This can be explained by the fact that the uncorrected index of the kerosene varies directly with the wave-length, while the uncorrected index of the alphamonochlornaphthalene varies

inversely with the wave-length (see Fig. 5). As, then, the concentration of the kerosene becomes less, the curves take on a negative slope. The interesting conclusion that can be made is that there is a point where the trends of the two liquid readings cancel each other and wave-length has no effect on the refractometer readings. It must be remembered that, although these readings might be constant over the spectral range, the actual index of the fluid does vary because of the wave-length corrections. Fig. 6 shows more readings taken on bottle No. 1 at 28° C. plotted to a larger scale.

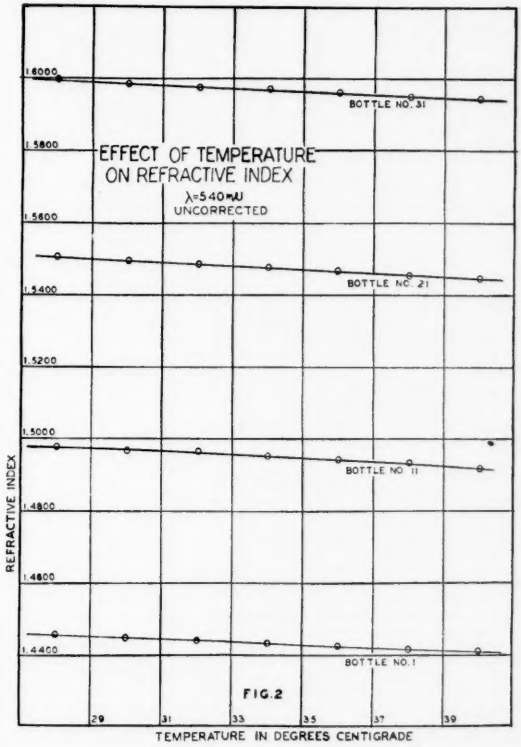


FIG. 2

Fig. 7 presents the effect of wave-length on the actual indices of the fluids. It is noted that the trend of the curves has been reversed, which emphasizes the importance of the correction curve. In addition, the dispersion of the fluids with a higher index has been greatly increased while the dispersion of the lower bottles is less. An examination of Fig. 8 demonstrates quite clearly why the curves are reversed as well as the cause of the different magnitudes of chromatic dispersion. The effect of wave-length on the actual indices of the two end members is an inverse function

which when combined produce the curves as shown in Fig. 7. In addition, the larger dispersion of the kerosene as compared with the alphamonochlornaphthalene explains why the dispersion of the higher index bottles, wherein the concentration of kerosene is higher, is greater than the dispersion of the lower bottles. Fig. 9 shows the corrected data as presented in Fig. 6 for bottle No. 1.

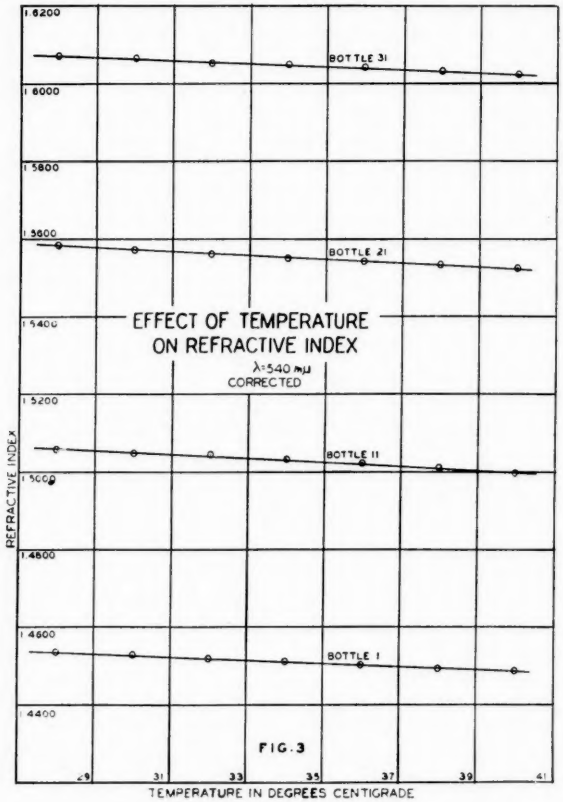


FIG. 3

Mounting of Specimen

Before the equipment could be made ready for the first determinations, a suitable cement for the glass windows of the constant temperature cell on the stage of the microscope had to be found. In addition, the correct size and thickness of glass had to be determined. The first cement attempted was bi-focal cement. This was allowed to harden for twenty hours but was

found to be unsatisfactory when subjected to temperatures over 32° C. and the pressure of the circulating water. Canada balsam was next attempted and found satisfactory as a binder, but it was miscible with the immersion fluids. Other cements such as rubber cement and the collodion types were used but were found wanting. Finally, De Khotinsky cement was applied and it fulfilled all requirements. This cement could withstand the necessary pressure and temperature and was not miscible with the

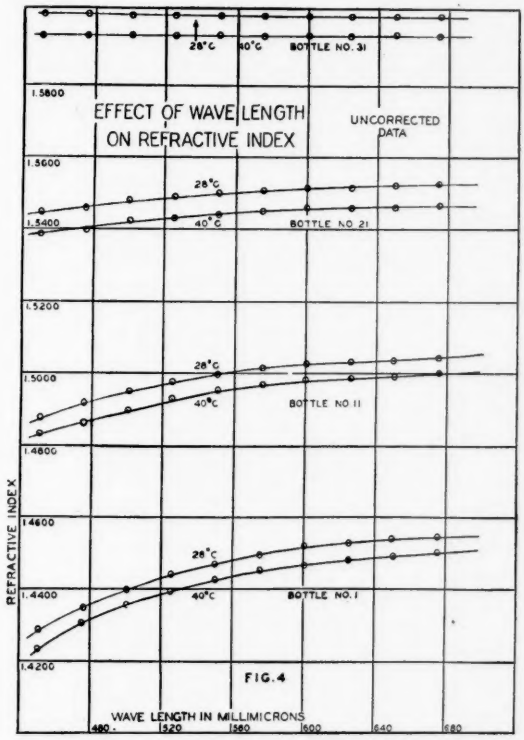


FIG. 4

immersion fluids or benzol which is used for flushing purposes. After trying several sizes of cover glasses, it was found that No. 2 (⅞ inch diameter) cover glasses were satisfactory. These glasses could withstand any stress due to temperature strains that was encountered as well as the pressure resulting from the maximum flow of circulating water.

The apparatus was now ready for sample determinations. The procedure that was followed and a few of the precautions and suggestions for correct manipulation are outlined as follows:

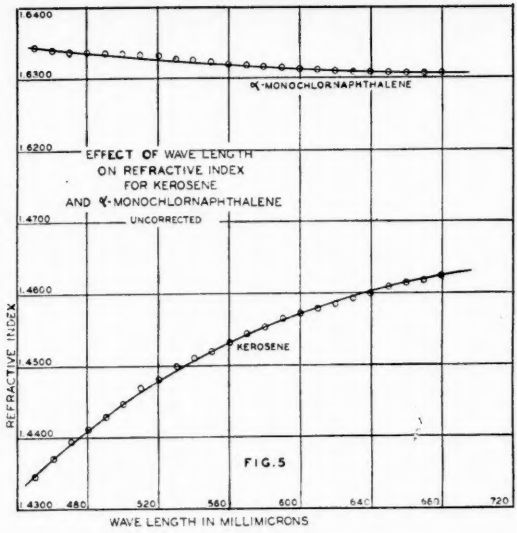

1.6400
1.6300
α-MONOCHLORNAPHTHALENE
1.6200
EFFECT OF WAVE LENGTH
ON REFRACTIVE INDEX
FOR KEROSENE
AND α-MONOCHLORNAPHTHALENE
UNCORRECTED
1.4700
1.4600
1.4500
KEROSENE
1.4400
1.4300
480
520
560
600
640
680
720
REFRACTIVE INDEX
WAVE LENGTH IN MILLIMICRONS

FIG. 5

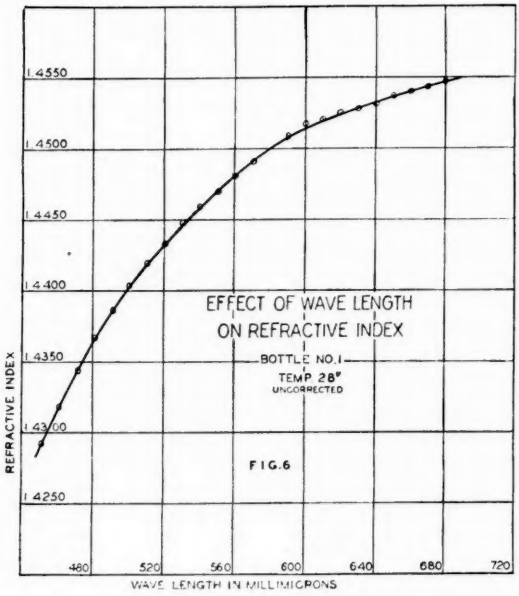
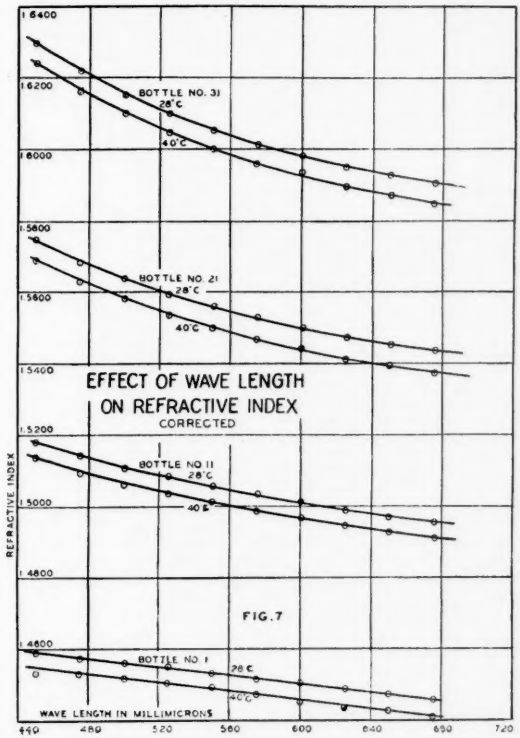

1.4550
1.4500
1.4450
1.4400
EFFECT OF WAVE LENGTH
ON REFRACTIVE INDEX
1.4350
BOTTLE NO. 1
TEMP. 28°
UNCORRECTED
1.4300
1.4250
480
520
560
600
640
680
720
REFRACTIVE INDEX
WAVE LENGTH IN MILLIMICRONS

FIG. 6

The circulating water should be flowing at a uniform rate, and preferably at 500 cc. or 1000 cc. per minute, to facilitate duplication of temperatures from the curves. Tap water can be circulated at its normal temperature for the first determination. The specific temperature of the water, hence fibre and immersion fluid, is not so important as the relative



temperatures of the fibre and its fluid to the same fluid in the refractometer. It is this temperature difference that must be kept a minimum.

After a type of fibre is selected, it is a matter of time-saving importance to find its approximate index and to use this as a starting point. A list of such indices may be found by A. Herzog [7] or Frey.[8] One of the bottles of the immersion fluids should now be selected with an index approximating one of the fibre indices. The fibres should then be mounted in the fluid and a drop of the fluid placed in the refractometer.

Measurement of Indices

After a period of time (in this case about three minutes) the fibre should be oriented either parallel or perpendicular to the plane of polarization by rotating the microscope stage. The position of orientation is selected according to which of the anisotropic indices is being found. Note should then be made of the direction of the Becke line movement in order to ascertain whether the fibre is of higher or lower index than the fluid. These Becke line movement observations were all made when the microscope was being focused up *from clear focus at the fibre edge.* If the fluid is

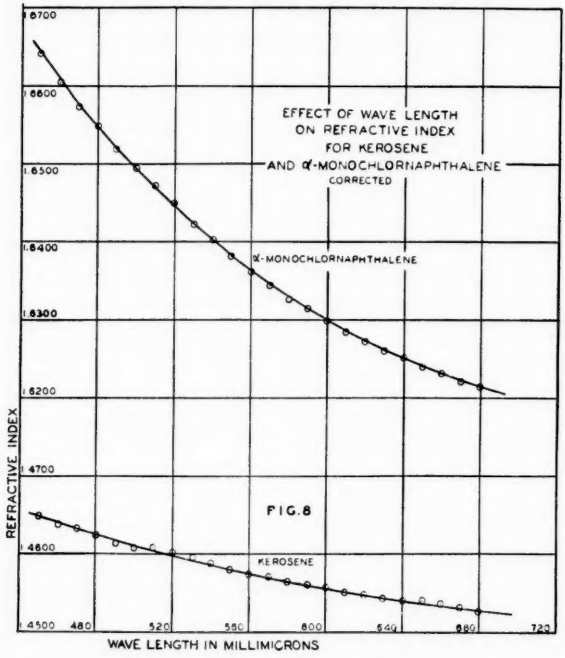


FIG. 8

higher than the fibre, *a fluid of lower index should be selected.* This procedure should be followed until the Becke line is seen to move in the opposite direction. When this is noted, the range of the desirable fluids to be uesd is known. After selecting the fluid that most closely approximates the fibre index, the wave-length of light can be varied in order to arrive at the point where the fibre moves to extinction. This is a point of utmost delicacy and too much care cannot be exercised. The point of extinction is not an instantaneous setting but may well extend over a range of 30 to 40 mu. Although this range of wave-length may represent only a change of $\pm$ .003 in refractometer reading, it may well mean as much as much as $\pm$ .005 in true index, depending, of course, upon the location in the spectral range

that the match occurs. A solution to this apparent lack of sensitivity is to note the wave-lengths at which the fibre disappears and then once more appears in the field and take an average between these two readings. This assumption of linearity may safely be made as the chromatic dispersion curves are nearly linear over this short range of wave-length. The ideal condition is to have the fibre reach its extinction point about midway in the visibility range. Such a position allows the fibre to be seen in the lower wave-lengths with its accompanying Becke line moving in one direction, and then pass through the point of index matching and finally reappear in the higher wave-lengths with the Becke line moving in the opposite direction.

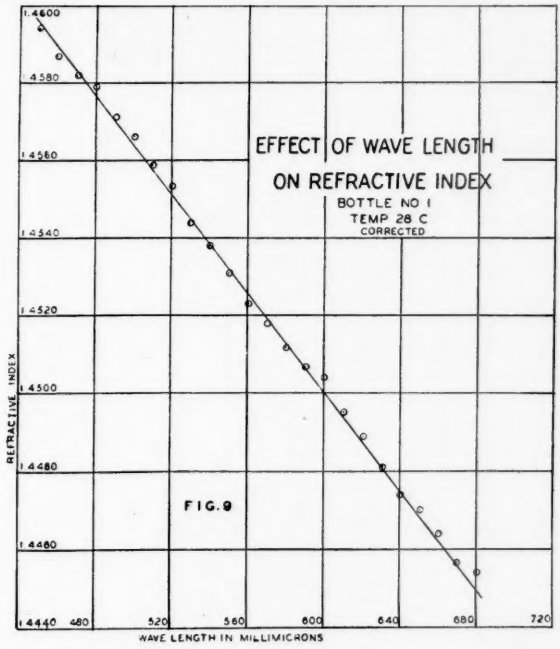


FIG. 9

Desirable Precautions

There is one definite precautionary measure that is advisable at this point in the procedure. It is not always possible to locate the critical point of matching in the center of the visibility range. Such a condition means that the reversal of the Becke line movements cannot be seen in one fluid range. It is entirely possible that a match of indices appears to be met when this relationship has not taken place. This phenomenon may be the result of poor visibility at the critical point, or may be due to "color

matching,'' *i.e.*, the fibre pigment to the wave-length color. To offset this complication, the following technique may be employed to good advantage: Select a bottle of higher index and lower this index by raising the temperature of the circulating water until the index of the match point has been reached. The degree to which the temperature must be raised can be determined from the curves supplied as in Fig. 3. This allows the match point to be read at a different wave-length of light thus obviating such complications as mentioned. Obviously, this procedure provides a positive check of the critical point. The light emanating from the monochromator can now be directed into the refractometer in order to determine the refractive index of the fluid and, consequently, of the fibre. A check should be made at this point of the temperatures just before the refractometer and just after the microscope in order to be certain of satisfactory thermal conditions.

The following tables present a sample of the data taken in test determinations as well as a measure of the dispersion in each table:

Bleached Ramie Indices

TABLE A

Bottle	Refractomerer °C.	Microscope °C.	λ mu.	Index (ε)
24	25.5	25.4	575	1.5678
24	25.4	25.3	552	1.5719
24	25.3	25.3	532	1.5748
24	25.4	25.4	597	1.5660
24	25.4	25.3	564	1.5698
24	25.4	25.3	557	1.5708
24	25.3	25.4	535	1.5744
24	25.7	26.0	563	1.5702
24	25.7	25.9	552	1.5717
24	25.7	25.9	561	1.5703

Mean, 1.5708. Ave. dev., 0.0020.
Std. dev., 0.0025. Coeff. of variation, 0.159%.
ε = index with light vibrating parallel to fibre axis.

TABLE B

Bottle	Refractometer °C.	Microscope °C.	λ mu.	Index (ω)
14	25.7	25.8	598	1.5281
14	25.7	25.8	503	1.5275
14	25.6	25.8	501	1.5280
14	25.6	25.7	498	1.5281
14	25.6	25.8	508	1.5266
14	25.6	25.8	496	1.5285
14	25.7	25.8	510	1.5263
14	25.5	25.6	508	1.5269
14	25.5	25.6	593	1.5291
14	25.5	25.6	504	1.5275

Mean, 1.5277. Ave. dev., 0.0007.
Std. dev., 0.0008. Coeff. of variation, 0.0524%.
ω = index with light vibrating perpendicular to fibre axis.
Specific index (ε − ω) = 0.0431.

These values are for bleached ramie, the indices being measured with light vibrating parallel and perpendicular to the fibre axis. Table A shows a larger standard deviation and coefficient of variation than does Table B. This relationship is to be expected as each reading was taken on a separate fibre and the latter indices are more stable. The indices of the viscose rayons mentioned in a previous foot-note also indicate this fibre characteristic. These dispersion measurements, therefore, do not depict the sensitivity of the equipment alone but also fibre variation. In addition, there are other less easily controlled variables of smaller magnitude, such as the spectral purity of the light used, rates of immersion fluid penetration, intrinsic errors of the instrument, and any human error that may be involved. Upon reconsidering the standard deviation and coefficient of variation for Table B, it can be safely concluded that the apparatus is undoubtedly as sensitive as 0.0005 in an index value. Such sensitivity as this is an encouragement to proceed to further work on precision measurements of refractive indices and allied phenomena of textile fibres.

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Abstracts

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I. Fibres (Synthetic and Natural) and Fibre Analysis

Keratins: Composition of. R. J. Block. *J. Biol. Chem.*, 1939, V. 128, P. 181–6; abs. in *J. Soc. Dyers Col.*, Sept. 1939, P. 467.

The amounts of some eight amino-acids occurring in a number of keratins including wool and human hair have been determined. The results indicated that the molecular ratios of histidine to lysine to arginine remained relatively constant, whereas considerable variation was found in the relative amounts of cystine, tyrosine, tryptophane, phenylalanine, and glycine. The data support the suggestion that the special function of the basic amino-acids is to give to a protein its group or general characteristics. (C)

Raw Wool Washing at the Isoelectric Point. *Wollen. u. Leinenind.*, 1939, V. 59, P. 164–5; abs. in *J. T. I.*, July 1939, P. A465.

If raw wool is washed at the isoelectric point (pH 4.9), it is claimed that the fibre resists chemical and physical alteration; there is no felting and the least possible amount of swelling. Both ionic and non-ionic scouring agents may be used. Isoelectric scouring is usually done at 50° C. and drying at 30–35° C. The Duhamel suint scouring process, although not as satisfactory as the isoelectric process, operates within the isoelectric zone of pH 5–7. (C)

RAW COTTON: GRADE DETERMINATION BY CHEMICAL ANALYSIS. S. Gontscharow and F. Burwasser. *Sbirnik Inst. chem. Tech. Akad. Nauk U.S.R.R.*, 1938, No. 7, P. 145–9 (through *Chem. Zentr.*, 1939, i, P. 561); abs. in *J. T. I.*, July 1939, P. A480.

The use of pyridine in the method for determining impurities in cotton is avoided by employing as solvent for the cellulose a mixture of 80% sulphuric acid and 20% acetic acid. (C)

STAPLE FIBRES: PROPERTIES. R. Schwab. *Klepzig's Textil-Z.*, 1939, V. 42, P. 387–9, 397–8; abs. in *J. T. I.*, Aug. 1939, P. A541.

The rapid development in staple fibre production in Germany in recent years is reviewed and tables are given showing fineness and dry and wet strengths and extensibilities of the various types of cotton and wool and the cotton and wool-type staple fibres. Curves showing elastic, residual and total extensions of wool and various wool-type staple fibres are compared. Staple fibre products with surface scale structures are briefly discussed and it is pointed out that staple fibre with a cellulose basis does not felt. Breaking twist and known strength data for various staple fibres are given. (C)

STAPLE FIBRE YARNS AND FABRICS: INFLUENCE OF FIBRE FINENESS AND STAPLE LENGTH ON PROPERTIES. O. Johannsen and H. Köb. *Klepzig's Textil-Z.*, 1939, V. 42, P. 333–42; abs. in *J. T. I.*, Aug. 1939, P. A542.

Yarns of various counts were prepared from Flox staple fibre of 1.5, 2.0, 2.5 and 3 denier and 38 mm. staple length and critical twist, strength, extensibility, substance-utilization, extension-utilization, irregularity and other properties of the yarns were determined. Tests were also made on yarns prepared from staple fibre of 1.5 and 2.2 denier of staple lengths 38, 44 and 60 mm. Fabrics in plain and twill weaves were woven from yarns of the same counts but spun from fibres of different denier and tested for strength and extensibility, air permeability, bursting strength and other properties. The results are shown in tables and graphs and are discussed. In general, the coarser fibres produce yarns and fabrics of lower strength, the effect being more noticeable in yarns than in fabrics. Other properties are also influenced by the fineness of the fibres. The effects of higher denier can to a limited extent be balanced by the use of longer staple lengths. (C)

VISCOSE STAPLE FIBRE: SOLUBILITY IN CAUSTIC SODA. W. Schramek and H. Christoph. *Kolloid Beihefte*, 1938, V. 48, P. 227–340; abs. in *J. T. I.*, Aug. 1939, P. A542. (C)

WOOL: ACTION OF LIGHT ON. S. R. Trotman and W. W. Taylor. *Analyst*, 1939, V. 64, P. 406–9; abs. in *J. Soc. Dyers Col.*, Sept. 1939, P. 467.

Exposure of wool to ultra-violet light increases its solubility in alkali and also in water. The principal action appears to be the breaking down of sulphur linkages thus liberating hydrogen sulphide which is subsequently oxidized by air (or possibly ozone) to sulphuric acid. Neutral wool (Botany tops and web were used) is more susceptible to the action of light than either acid or alkaline wool and acid wool is more susceptible than alkaline wool. Structural damage was found to be very slight with

acid and alkaline wools, but was marked with neutral wool. The effects were more pronounced with tops than web, probably owing to the greater surface of the former per unit mass used in the experiments. (C)

II. Yarns and Fabrics

Tension on the Weft during Weaving. E. Ullrich. *Mell. Textilber.*, 1939, No. 7, P. 489–92.

The article deals chiefly with the braking and guiding of the yarn in the shuttle. Details are given of the various types of brake which may be of fabric or some soft material, or pin, spring, lever, and roller brakes. A large number of different designs are discussed with reference to the patent literature. Finally reference is made to an apparatus for measuring the tension exerted on the yarn when it is drawn off in the shuttle, thereby making it possible to set the shuttle brakes uniformly for the most diverse types of shuttle. The apparatus consists chiefly of a small electric motor and a yarn tension dial gauge. (C)

Testing Elastic Yarns. *Text. Recdr.*, July 6, 1939, P. 37.

Methods of testing Lastex yarn to determine its quality and resistance are noted but not explained in detail. (C)

Textile Drying Machinery. W. W. Spooner. *J. Soc. Dyers Col.*, June 1939, P. 303–8.

Convection drying of textiles by hot air currents with special reference to dryers made by the author's company. (C)

Twist in Continuous Filament Rayon Yarns: Theory and Experiment. "Investigator." *Silk & Rayon*, April 1939, P. 309–10, 312.

Also considers twist in relation to crêpes and to spun rayons. (C)

Warp Knitting: Machinery Developments in. J. B. Lancashire. *Silk J. & Rayon Wld.*, Mar. 1939, P. 35–6. (C)

Warp Separator. Gebrüder Sucker G.m.b.H. (München-Gladbach, Germany). B.P. 499,459 of 3/8/1938: 24/1/1939; abs. in *J. T. I.*, April 1939, P. A238.

A meter indicating the amount of energy expended for effecting the separation is incorporated in the warp separator through which warps pass from dressing apparatus to the beam. The separator is resiliently supported or mounted so that it yields elastically, up to a point, to the pull of the warp yarn drawn through it, and it is connected to a pointer or indicator which indicates on a scale the amount to which it has yielded, this being a measure of the dressing which causes the warp yarns to cling to each other and resist passage through the separator. (C)

Warp Size Distribution on Yarn. W. E. Yelland. *Text. Mfr.*, July 1939, P. 300; *Text. Rsch.*, June 1939, P. 285–91. (C)

Wet Fabrics: Moisture Removal by Centrifuging, Suction and Drying Processes. H. Leppin. *Monatsh. Seide u. Kunstseide*, 1939, V. 44, P. 91–4; abs. in *J. T. I.*, June 1939, P. A393.

In wet fabrics water is held between the yarns, between the fibres of which the yarns are composed, and also as water of swelling in the fibres.

Mechanical processes, such as centrifuging, suction and squeezing, remove only the water between the yarns and fibres, and the water of swelling can only be removed by drying processes. Tables and graphs are given showing the changes in moisture contents of cotton, wool, silk and rayon fabrics on centrifuging and subjecting to suction, and the changes in the moisture contents and temperatures of the fabric and the hot air in a drying process. Details are given of temperatures, moisture contents, etc., of air and fabric on entering and leaving a drying chamber, temperatures in the chamber, volumes of air used, heat and steam requirements, etc., in a fabric drying process. (C)

WINDING MACHINERY: MODERN. Ralph Chisholm. *Canadian Text. J.*, 1939, May 26, P. 29–31; June 23, P. 40–2; July 21, P. 36–7.

Mechanisms and performance of the modern Universal Roto-Coner designed for winding soft twisted yarns; principal features of the redesigned Universal No. 50 Precision Machine which will wind a wider variety of yarns and produce new types of larger packages, and principal features of the No. 90 Bobbin Winder and the new Universal No. 99 Automatic Machine which operates at 5,000 r.p.m. on rayon yarns. (C)

WOOL: COMPLETELY NON-FELTING—AND ITS USE IN TEXTILE MATERIALS. A. J. Hall. *Text. Mfr.*, June 1939, P. 270.

Abstract of a paper at recent annual conference of The Textile Institute at Bath, Eng. (C)

WOOL: NEW SYNTHETIC TEXTILES IN RELATION TO. H. A. Thomas. *J. Soc. Dyers Col.*, Feb. 1939, P. 57–68.

The author first summarizes the most important physical properties of wool, noting that no synthetic fibre has more than a few of these characteristics. He then classifies and describes the imitation fibres as follows: All-protein fibres; fibres of regenerated cellulose containing protein; animalized or basified viscose rayon; synthetic resin fibres; physically-modified viscose staple fibres. Photomicrographs of many of the fibres and their cross-sections are given as reproduced from *Klepzig's Textil-Zeitschrift*. Methods of identifying the various imitation fibres are explained, and the balance and largest part of the paper discusses their dyeing properties and the dyeing problems presented by their use in union fabrics. Of particular interest is much of the appended discussion of the paper. (C)

WOOL SCOURING: EFFICIENCY IN. Donald Wilson. *Wool Record & Text. Wld.*, July 13, 1939, P. 83–5; July 20, P. 141–3.

Describes methods by which the wool will not only be left clean, free and open, but will have its natural properties unimpaired. (C)

WOOL WARPS: NEW SIZE FOR. *Text. Mfr.*, July 1939, P. 299, 321.

Tylose, a cellulose derivative, its use for sizing wool and mixed warps, and methods of removal in finishing. (C)

WOOLEN CARDING: ANALYSIS OF SPEEDS IN. G. Marshall. *Wool Record & Text. Wld.*, Jan. 5, 1939, P. 33–8. (C)

III. Chemical and Other Processing (Not Otherwise Classified)

Acetate Rayon Dyer: Some Problems of the. G. H. Lister. *Text. Mfr.*, May 1939, P. 224–5.

Discusses the importance of dispersion in acetate dyeing; faults to which there is a tendency, and choice of dyes. (C)

Acetate and Viscose Rayon Fabrics: Processing of. C. B. Ordway. I. Preparation of Rayon and Acetate Rayon Greige Goods and the Crêpeing Process. *Am. Dye. Rptr.*, Aug. 8, 1938, P. 431–8; II. Bleaching and Finishing of Acetate and Viscose Rayon Crêpes. *Ibid.*, Oct. 3, 1938, P. 541–2, 552–5; III. Dyeing of Acetate and Viscose Rayon Crêpes. *Ibid.*, Dec. 12, 1938, P. 732, 749–55; IV. Finishing of Acetate and Viscose Rayon Crêpes. *Ibid.*, Jan. 9, 1939, P. 5–10; V. Preparation, Bleaching and Dyeing of Acetate Rayon Flat Goods. *Ibid.*, Mar. 6, 1939, P. 111–14, 134–5; VI. Bleaching and Dyeing Operations for Acetate Rayon Flat Goods. *Ibid.*, July 24, 1939, P. 382–4, 397–9. (C).

Acid Dyes in the Processing of Various Shades on Animal Fibre: Notes on the Tinctorial Function of Component. Arthur Ellis. *Text. Col.*, Dec. 1938, P. 817–20; Jan. 1939, P. 14–16. (C)

Azo Dyes: Electrolytic Formation. C. J. Brockman and J. W. Griffin. *Electrochem. Soc. Preprint*, 1939, V. 75, No. 4, P. 19–25; abs. in *J. T. I.*, June 1939, P. A395.

The authors have studied the production of azo dyes at platinum or nickel anodes in a divided cell with an anolyte containing the requisite organic compounds in the sodium nitrite solution. Tables of results are given. (C)

Casein Fibre Combed Sliver: Dyeing. E. Riedel. *Klepzig's Textil-Z.*, 1939, V. 42, P. 257–8; abs. in *J. T. I.*, June 1939, P. A396.

Details are given of procedures for the dyeing of casein fibres in the form of combed sliver wound on bobbins with Immedial, Immedial leuco, Helindon and Palatine fast dyes. (C)

Cellulose Derivatives: Properties and Uses of Non-thermoplastic. K. Sponsel. *Kunststoffe*, 1938, V. 28, P. 320–3; abs. in *J. T. I.*, April 1939, P. A244.

The properties of cellulose and cellulose derivatives that are of importance in their use for the production of films and similar products and in their use as binding, finishing and emulsifying agents are discussed, and the properties and uses of nitrocellulose, cellulose acetate, viscose, and water-soluble and alkali-soluble cellulose ethers and of products obtained from them are described. (C)

Dyeing of Rayon Staple. F. Bonnet. *Am. Dye. Rptr.*, July 24, 1939, P. 391–4.

A paper delivered at the May 1939 meeting of the Southeastern Section of A. A. T. C. C. The dyeing of viscose staple forms the major part of the discussion. (C)

SURFACE-ACTIVE CHEMICALS. George A. Thomas. *Text. Wld.*, Jan. 1939, P. 58–9.

Gives data on specific textile applications. (C)

(NEW) SYNTHETIC FIBRES IN THE DYEING AND CLEANING INDUSTRY. B. Brown and Sylvia M. Brown. *Text. Mfr.*, June 1939, P. 269; *J. T. I.*, July 1939, P. P166–8.

Abstract of a paper at recent annual conference of The Textile Institute at Bath, Eng. (C)

THICKENING AGENTS: MIXED POLYMERIZATION PRODUCTS OF POLYACRYLIC ACID AS. Hanns Gerber. *Mell. Textilber.*, 1939, No. 4, P. 287.

The experiments described used an aqueous solution of mixed polymerization products of polyacrylic acid as thickening for printing colors. (C)

TITER TEST. Henry Barker Burke. *Am. Dye. Rptr.*, July 10, 1939, P. 355–7.

An explanation of the test, its purpose and explanatory comments upon its value from a practical viewpoint. (C)

VERSUS FIBRE DAMAGE IN RESIN TREATMENT. J. Wakelin. *Silk & Rayon*, Jan. 1939, P. 68, 70.

The author discusses the question of their alleviation and prevention. As cotton or rayon which is being resin-impregnated has to undergo heating to 150° C. in contact with acids, the presence of destructive influences is self-evident. (C)

WETTING AGENTS: NEW USES FOR. J. Wakelin. *Text. Col.*, Mar. 1939, P. 193–4, 202; reprinted from *The Mfg. Chem.* (C)

WOOL: DISSOCIATION OF AMMONIUM SALTS IN CONTACT WITH. Part I. H. Briggs and F. L. Goodall. *J. Soc. Dyers Col.*, July 1939, P. 354–60.

The behavior of five ammonium salts, *viz.*, the chloride, sulphate, formate, oxalate, and acetate, in solution at the boil has been examined in relation to their uses in practical dyeing. The experimental method is described, and no evidence of acid volatilization was obtained with any of the salts. (C)

WOOL DYEING: EFFECT OF METALS IN. "INDIGO." *Text. Recdr.*, Jan. 6, 1939, P. 33–5.

Second part of an article in which the author discusses the various metals used in dyeing machines and their effects on the dyed materials. (C)

WOOL FABRICS: INFLUENCE OF DYES AND DYEING PROCESSES ON THE MILLING, STRENGTH, AND WEARING PROPERTIES OF WOOL FABRICS. W. T. Liu, J. B. Speakman and P. E. King. *J. Soc. Dyers Col.*, April 1939, P. 183–92.

As a result of an examination of the strength and wearing properties of dyed and undyed wool fabrics, it has been shown that when normal amounts of acid and dye are used, dyeing processes have little adverse

effect on the properties of the fibres. Indigo, on the other hand, is the only dye which, when used in small percentages, has been found to have a beneficial effect on the wearing properties of wool fabrics. In mordanting processes, the extent to which wool is damaged by potassium bichromate increases with fall of pH on account of disulphide bond attack. When reducing agents are introduced into the chroming bath, therefore, the greatest protective effect is given by compounds which are only weakly acidic. As regards the various methods of applying mordant dyes, the chromate process seems to be less harmful to wool than on-chrome and after-chrome processes. One reason for the superiority of the chromate process is, of course, the fact that the pH of the dyebath is close to the pH at which wool is least damaged at the boil. Although the strength and resistance to wear of wool fabrics may be increased when they are dyed with high percentages of Solway Green GS or Solochrome Black WDFA (afterchromed), their milling properties are correspondingly diminished. Similarly, the milling properties of wool fabrics are impaired by treatment with the tannic acid-tartar emetic resist. (C)

WOOL FIBRE: PROTECTION OF—DURING SCOURING AND DYEING. R. A. Lindenmaier. *Am. Dye. Rptr.*, Jan. 9, 1939, P. 15–17.

Paper presented at meeting Northern N. E. Section, A. A. T. C. C., Nov. 4, 1938. (C)

WOOL: FINE STRUCTURE OF. PART II. K. Ohara. *Mell. Textilber.* (German Edition), 1939, No. 5, P. 326.

The author pointed out in a former communication that the dyeing properties of merino wool when dyed with basic dyes varies according to the sides of the curve of the curl, because the outer and inner sides of the curvature are negatively and positively charged respectively. It was supposed that this difference stood in some relation to the density of the curvature of the wool. In order to prove that assumption, an Australian merino wool was examined by refractometer. The refractive index of the wool was determined by Becke's method and the specimens were embedded in a liquid composed of alpha-monobrom-naphthalene and clove oil at 20° C. The refractive index of the liquids was determined at each examination by means of a Pulfrich refractometer in sodium light at 20° C. It was shown that there is actually a difference in density on the curvatures. That is probably one of the reasons for the difference in the behaviour of wool when dyed with basic dyes. (C)

WOOL: UNLEVEL DYEING OF—WITH ACID AND CHROME DYES. Race, Rowe and Speakman. IV. CHROMIUM ACETATES. PREPARATION AND CHARACTERISTICS OF THE CHROMIUM ACETATE MOST EFFECTIVE IN CORRECTING THE UNEVEN DYEING PROPERTIES OF WOOL DAMAGED BY EXPOSURE. *J. Soc. Dyers Col.*, Feb. 1939, P. 69–82. V. AN EXAMINATION OF EFFICACY OF CHROMIUM SALTS IN ACIDS OTHER THAN ACETIC ACID IN CORRECTING THE UNEVEN DYEING PROPERTIES OF WOOL DAMAGED BY EXPOSURE. *Ibid.*, P. 82–6. VI. *Ibid.*, May 1939, P. 258–61. AN EXAMINATION OF THE POSSIBILITY OF USING A STANDING BATH IN THE CHROMIUM ACETATE PROCESS FOR CORRECTING THE UNEVEN DYEING PROPERTIES OF WOOL STAPLES AND OF CLOTH DAMAGED BY EXPOSURE (C)

IV. Research Methods and Apparatus

Animal Fibres: Measurement of Cross-sectional Contour or Ellipticity of. A. B. Wildman. *14th Int. Wool Conference, London*, 1938, *Tech. Cttee. Proc.*, P. 69–72; abs. in *J. T. I.*, April 1939, P. A258. (C)

Brabender Viscose Ripening Tester. *Silk and Rayon*, 1939, V. 13, P. 327; abs. in *J. T. I.*, June 1939, P. A374.

An illustration is given of a testing instrument in which the viscose is rotated in a stainless steel cylinder by means of a synchronous motor and the ammonium chloride is automatically introduced from a burette in even quantities and at an even rate. A "feeler" dips into the viscose and automatically registers the resistance to flow. The sudden change in viscosity on coagulation is obvious on the diagram and the volume of ammonium chloride corresponding with the break in the curve gives the degree of ripening. (C)

Copper and Manganese in Fabrics: Determination of. A. Ruthing. *Kautschuk*, 1938, V. 14, P. 210–2 (through *C. A.*, 1939, V. 33, Col. 1502); see also *Chem. Ztg.*, 1930, V. 54, P. 403; abs. in *J. T. I.*, April 1939, P. A261. (C)

Count Variation in Worsted Yarns. C. Brook. *Text. Mfr.*, June 1939, P. 243.

Allowable variation of fineness of worsted yarns and steps required in drawing processes to ensure accuracy. (C)

Crimp in Raw Wool: Measurement of. Wool Industries Research Assoc. *14th Int. Wool Conference, London*, 1938, *Tech. Cttee. Proc.*, P. 80–2; abs. in *J. T. I.*, April 1939, P. A258.

Two figures are required to define the degree of crimp in wool fibres. The amplitude of crimp may have a more direct bearing on the properties of the wool than the ratio of crimped to stretched length, and a simple way of deducing it from the number of crimps per cm. and the ratio of crimped to stretched length is indicated. (C)

Drying Apparatus Automatic Controls. H. Rammensee. *Klepzig's Textil-Z.*, 1939, V. 42, P. 173–4; abs. in *J. T. I.*, June 1939, P. A392.

The different types of drying systems used in the textile industry are briefly discussed and the use of automatic temperature controlling devices is mentioned. It is pointed out that air coming from the drying chambers is generally far from saturated and an automatic system for controlling recirculation of the air according to its degree of saturation is briefly described. In this system a moisture content measuring device controls a valve which regulates the recirculation of the air when the saturation is below 80–85%. When the saturation is above this limit the valve closes and the air is blown out. (C)

Wettability and Rate of Evaporation of Fabrics: Procedure for Testing the. F. M. Peschel. *Am. Dye. Rptr.*, Feb. 6, 1939, P. 61–2; *Rayon Text. Mo.*, Jan. 1939, P. 72.

Describes an apparatus and test method developed by U. S. Testing Co., to determine what the differences in the rate of absorption and evapo-

ration from various types of treated and untreated fabrics might be when in contact with the human body under conditions of excessive perspiration. The loss in moisture through evaporation from the surface of a fabric, which is continuously supplied throughout the test with replacement moisture, was tabulated at observed intervals. (C)

WOOL: DETERMINING ACID IN. F. G. Brown. *Text. Col.*, April 1939, P. 250, 273.

Barritt, Bowen, Goodall and Whitehead (*Analyst*, 63, 782) believe that Trotman and Bramley's opinion (*Analyst*, 63, 405) that the pyridine method does not always return all of the acid is based on the use of too weak a pyridine solution: 0.1% instead of 0.5% as originally specified. They also think they make up for the advantage of the colorless distillate of the distillation method by a suitable choice of indicator as explained in this article. (C)

WOOL FINENESS AND LENGTH. H. Wilkinson. *Text. Mfr.*, July 1939, P. 291–2, 301.

Formulae for the measurement of fineness and length of wool fibres by the weight/length method, number of fibres in a yarn, etc. (C)

WOOL: METHOD OF TITRATION FOR DETERMINING DAMAGE TO. J. W. Gross, E. v. Roll and J. Schreiber. *Mell. Textilber.*, 1939, No. 5, P. 357–62.

The article contains a description of a newly developed method of diazo titration which appears to be adapted to follow up injury to wool rapidly and, within certain limitations, also quantitatively. Comparisons of damage found accompanied by photomicrographs are made and examples taken from working practice are explained. (C)

WOOL: A QUANTITATIVE METHOD OF DETERMINING SLIGHT INJURY TO. F. Patat. *Mell. Textilber.* (German Edition), 1939, No. 4, P. 277–80.

The author describes a method of quantitatively determining, in particular, slight injury to the wool fibre, whereby it is possible to observe the influence of the most important chemical reagents upon wool and the way they depend upon the temperature. The temperature coefficient varies according to the reagent added; it amounts, for example, to 1 %/degr. for $\frac{1}{10}$ n sulphuric acid, 2.6 %/degr. for distilled water, 3 %/degr. for $\frac{1}{10}$ n sodium sulphate solution, and 1.5 %/degr. for $\frac{1}{100}$ n potassium hydroxide. (C)

YARNS AND FABRICS: TESTING. F. Kurtz. *Klepzig's Textil-Z.*, 1939, V. 42, P. 275–8; abs. in *J. T. I.*, June 1939, P. A411.

It is pointed out that ordinary breaking load and extension tests do not give a satisfactory indication of the behavior of textile products in use, and the value of tests of the properties of most importance in actual use is emphasized. Elasticity determinations are recommended for the evaluation of yarns in relation to weaving qualities and typical data are given. The results of tests of the influence of open and closed shed formation on the elasticity and working power of yarns are also given and briefly discussed. The Zoppritz wear tester, the Dietz and Frenzel-Hahn continuous yarn testers, and the Schopper fabric bending resistance tester

are briefly described, and it is shown that various finishing treatments which have very little effect on the strength of viscose rayon fabrics have considerable effects on the resistance of the fabric to repeated bending. (C)

V. Pure Science, Economics and Misc.

Casein. "Classic." *Silk & Rayon*, Mar. 1939, P. 254, 256.

A summary of some of the more important developments published concerning this new textile material. (C)

Cellulose Compounds: Studies on. E. Berl and W. Koerber. *J. Amer. Chem. Soc.*, Jan. 1939, P. 154–7; abs. in *Eastman Kodak Abs. Bull.*, Mar. 1939, P. 180.

Cellulose esters insoluble in certain solvents or solvent mixtures at room temperature may become soluble at lower temperatures (— 50° C.). This can be explained by the formation of soluble molecular compounds, which dissociate at elevated temperatures, and by the exothermic character of the swelling reactions. (S)

Cellulose Derivatives: General Properties. R. Bluma. *Rev. gén. mat. plastiques*, Sept. 1938, V. 14, P. 245–9; abs. in *Eastman Kodak Abs. Bull.*, Mar. 1939, P. 179.

A review is given of the preparation and properties of ethyl cellulose, including the viscosities in numerous solvent mixtures at 15°, 32°, and 50° C., and the determination of the homogeneity by progressive precipitation. (S)

Cellulose: Methylation of. K. Freudenberg, E. Plankenhorn and H. Boppel. *Ber.*, 1938, V. 71, P. 2435–8; abs. in *J. Soc. Dyers Col.*, Feb. 1939, P. 109.

Cellulose can be completely methylated (45.6% OCH_3) by suspending bleached ramie fibres in liquid ammonia and treating repeatedly with sodium and methyl iodide at — 70° C. (C)

Cellulose: Network Structure of. O. Kratky. *Silk & Rayon*, 1939, June, P. 480–2; July, P. 571–2. (C)

Cellulose Reactions: Mechanism of. H. M. Spurlin. *Trans. Electrochem. Soc.*, 1938, V. 73, 13 pp. (reprint); abs. in *Paper Trade J.*, Mar. 2, 1939, P. 27. (C)

Cellulose Research, 1933–37. Louis Elsberg Wise. *Paper Ind.*, 1938, July, P. 413–6; Aug., P. 540–3; abs. in *Paper Trade J.*, July 27, 1939, P. 26.

A review with bibliography of 75 references. (C)

Celluloses: Solubility in Alkalis of Natural and Regenerated. H. Staudinger and I. Jurisch. *Kunstseide*, 1939, V. 21, P. 6–9; abs. in *J. T. I.*, April 1939, P. A285. (C)

COLOR: OBJECTIVE MEASUREMENT OF. J. W. Perry. *J. Sci. Instruments*, Aug. 1938, P. 270–7; abs. in *Eastman Kodak Abs. Bull.*, Mar. 1939, P. 175.

A photoelectric colorimeter is described which employs three filters to secure readings that are proportional to the I. C. I. trichromatic coefficients. The instrument is best suited for the comparison of similar samples of low saturation. (S)

COMMITTEE D–13: HISTORY OF. Horace J. Jaquith. *Rayon Text. Mo.*, 1939, Mar., P. 74–5; April, P. 75–6. (C)

COMMITTEE D–13 AND ITS RELATION TO THE TEXTILE INDUSTRY. H. J. Ball. *Rayon Text. Mo.*, April 1939, P. 76–7. (C)

DIELECTRIC CONSTANT OF CELLULOSE: MEASUREMENT OF THE. H. A. deLuca, W. B. Campbell, and O. Maass. *Canadian J. Rsch.*, Aug. 1938, P. 273–88; abs. in *Eastman Kodak Abs. Bull.*, Mar. 1939, P. 180.

The dielectric constant of cellulose was determined by measuring the capacity of a condenser containing the cellulose immersed in different solutions of two completely miscible liquids of known dielectric constant. A value of 6.1 was obtained for standard cellulose immersed in benzene and ethylene dichloride. (S)

DRYING: SOME PRINCIPLES OF. W. Cowen. *J. Soc. Dyers Col.*, June 1939, P. 290–302.

A very complete exposition of the fundamental principles on which the operation of drying by means of air currents is based. Includes a very complete bibliography. (C)

DYES: SUBTRACTIVE COLOR MIXTURE AND COLOR REPRODUCTION. (1) D. L. MacAdam. (2) J. A. C. Yule. *J. Opt. Soc. Amer.*, 1938, V. 28, P. 466–80; 481–92; abs. in *J. T. I.*, April 1939, P. A283.

A rule for approximately predicting the colorimetric specifications of subtractive mixtures of certain dyes is developed and incorporated into the theory of color reproduction. It leads to the conclusion that masking is an essential part of any subtractive process of correct color reproduction. Formulae for the calculation of the gradients of the masks are given. (C)

ENZYMATIC DIGESTION OF WOOL. J. I. Routh and H. B. Lewis. *J. Biol. Chem.*, 1938, V. 124, P. 725; through *Analyst*, 1938, V. 63, P. 742; abs. in *J. Soc. Dyers Col.*, Feb. 1939, P. 109.

Wool, free from fat, was very slowly attacked by trypsin. After such treatment, the wool was ground in a ballmill for a prolonged period and was then found to contain a higher proportion of ash and a lower proportion of cystine. The powdered wool yielded a water-soluble fraction containing nitrogen and sulphur, which was not attacked by trypsin. (C)